GERTSCH

INSTRUCTION BOOK
FOR
STANDARD RATIO TRANSFORMERS
"RatioTran"

PROPERTY OF DEPT. B-260
CALIBRATION & STANDARDS
DO NOT
REMOVE FROM AREA

ELECTRONIC INSTRUMENTS

GERTSCH
PRECISION ELECTRONIC INSTRUMENTS

GERTSCH PRODUCTS, INC.

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MAILING ADDRESS: P. O. BOX 25856, W. LOS ANGELES 25, CALIFORNIA

WARRANTY POLICY

Gertsch Products, Inc. guarantees any equipment which we manufacture to meet the advertised performance specifications applying to that particular equipment.

Gertsch Products, Inc. warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to making good at our factory any part or parts thereof except tubes, fuses or batteries which shall, within one year after making delivery to the original purchaser, be returned to us with transportation charges prepaid, and which on our examination shall disclose to our satisfaction to have been thus defective.

Gertsch Products, Inc. reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of Gertsch Products, Inc., and Gertsch Products, Inc. neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Gertsch Products, Inc. instruments.

This Warranty applies only to the original purchaser unless approval for resale is obtained in writing from Gertsch Products, Inc.

Equipment _____

Serial No. _____

Sold To _____

Date Sold _____

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9-27-56

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OPERATING INSTRUCTIONS FOR STANDARD RATIO TRANSFORMERS (RatioTrans)*

The following instructions include information for maintenance and operation of all Gertsch Standard Ratio Transformers.

These units fall into two broad groups:

1. Those designed particularly for low voltage, high frequency use.

2. Those designed particularly for high input voltage, low frequency use.

In the case of those units in the first group which are the Models PT-1, PT-2, PT-5, PT-6, PT-7, Model 10 and Model 11, the maximum input voltage must not exceed 0.35 times the frequency (the frequency being expressed in cycles per second). Under any condition the input voltage must not exceed 350 volts.

Maximum input voltage for the second group which includes the PT-3, PT-4, PT-8 and PT-9, is 2.5 times the frequency (the frequency being expressed in cycles per second) and must not exceed 350 volts.

Each instrument contains a name plate which includes a warning label specifying the voltage for which the particular unit was designed to operate. PLEASE READ NAME PLATE CAREFULLY.

Certain precautions must be taken in using those RatioTrans which are switched by means of push button switches. These are the Models PT-1, PT-2 and PT-3. When using these units with a high voltage input from a fairly low impedance source certain dangers exist.

Due to the switching arrangements, if two buttons in any given row are pushed at the same time, part of the transformer is shorted out. Circulating currents in this shorted section of the transformer can become very high and possibly either damage or burn out the transformer. For the same reason, if buttons are pushed very rapidly the winding may become shorted for an instant due to the inertia of the switch. This occurs when one button is pushed down so fast that the button which was previously down does not have time to disengage from its contacts before the button being pressed makes contact.

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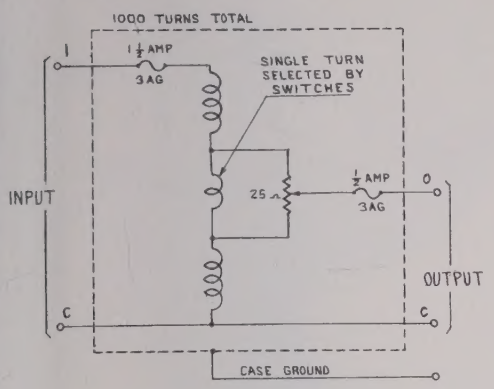
While these transient short circuits are not of particular danger to the transformer, they do cause considerable arcing at the contacts of the switches and are very likely to blow fuses when buttons in the first row are pressed. For this reason, it is recommended that enough series impedance be inserted with the source to limit the maximum short circuit current to 4 amps. This procedure will save many blown fuses and also prolong the life of the switches. The other branches of the bridge circuit should be connected directly across the transformer.

There is no way whereby the RatioTran can be protected from a burned out winding, in case two buttons are pressed in the same row. In some extreme cases, particularly in the first row of buttons, the primary fuse may blow and protect the transformer.

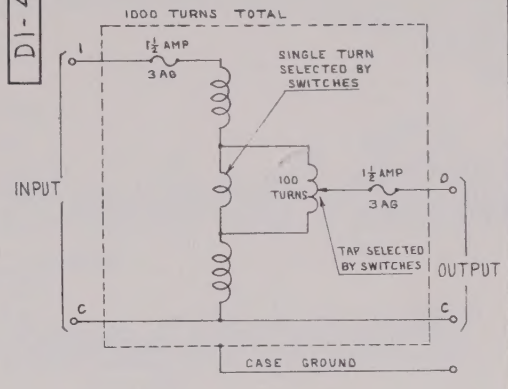
Following are descriptive sheets which contain pertinent electrical and mechanical specifications which pertain to each individual instrument.

Please note the following change in accuracy specifications. With the exception of the Models 10 and 11, for all units which were shipped prior to January 1, 1956 the accuracy indicated in the folder applies. On units shipped after this date the accuracy has been improved and should read .001% in all formula where the figure .004% is used. In other words, newer models have four times the accuracy of earlier types. For example, the attached information on the Model PT-1 shows its accuracy to be $\pm$ (.004% + $\cdot \frac{0006\%}{R}$). This should now read $\pm$ (.001% + $\cdot \frac{0006\%}{R}$).

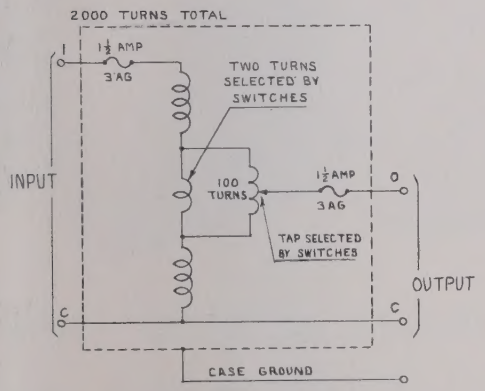
5/23/56



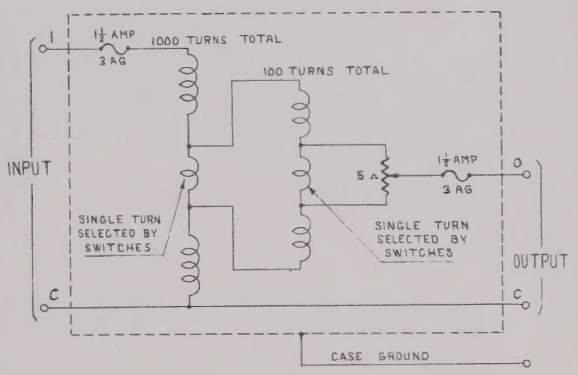
SCHEMATIC DIAGRAM
PT-1, MOD.10



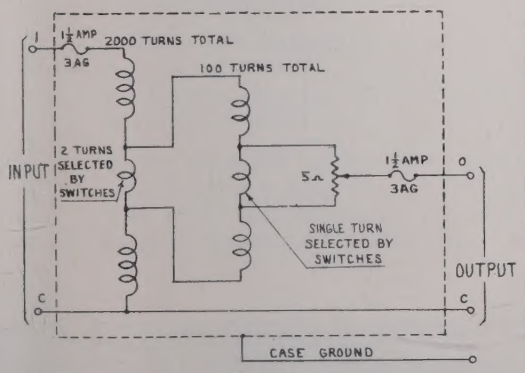
SCHEMATIC DIAGRAM
PT-2, PT-6



SCHEMATIC DIAGRAM
PT-3, PT-8



SCHEMATIC DIAGRAM
PT-5, PT-7, MOD. 11



SCHEMATIC DIAGRAM
PT-4, PT-9

REV. A
D1-43

-5	JOB NO	MODEL NO	
-4	JOB NO	MODEL NO	
-3	JOB NO	MODEL NO	
-2	JOB NO	MODEL NO	
-1	JOB NO	MODEL NO PT's	

REQUIRED

REV. A
NO. D1-43

DESCRIPTION
SCHEMATIC DIAGRAMS
RATIOTRANS

DR.		4-25-56
MECH. CHECK		5-23-56
ELEC. CHECK		
MECH. APP.		
ELEC. APP.		

FILE JOB NO.

GERTSCH PRODUCTS
INC.
LOS ANGELES CALIFORNIA

PART NO.
MATERIAL
FINISH

SCALE
ITEM NO.
DWG. SIZE

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN INCHES
TOLERANCES

BASIC DIM.	FRACTIONS	DECIMALS
UNDER 8	± 1/64	± .005
8 TO 24 INCL.	± 1/32	± .010
OVER 24	± 1/16	± .015

ANGLES ± ECCENTRICITY TIR.
HOLE DIA. ± SURFACES √
REMOVE ALL BURRS AND SHARP EDGES
COMMERCIAL TOLERANCE APPLY TO STOCK SIZES

REVISIONS

DIETZGEN-POST CLEARPRINT 100GH

IMPROVED ACCURACY UNITS

GERTSCH

Standard Ratio Transformers

RatioTran*

PT-1
Carrying Case Model
(Typical)

PRECISION AC VOLTAGE DIVIDERS

GENERAL DESCRIPTION STANDARD RATIO TRANSFORMERS (RatioTran*)

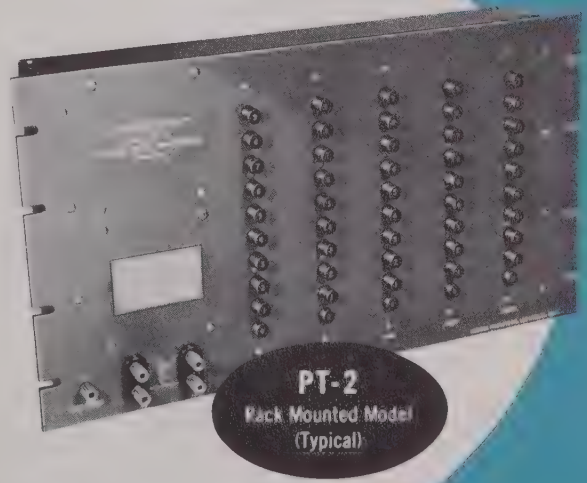
Precision Auto-Transformers capable of Extreme Accuracy and Resolution in the Measurement and Generation of AC Voltage Ratios.

The same basic principle of operation is applicable to all units in the Series, however each has been designed for a specific application.

PT-1 A wide frequency range unit with limited input voltage characteristics at lower frequencies. Uses push button selection for the first three digits and a ten turn potentiometer for the remaining.

PT-2 Covers the same frequency and voltage ranges as the PT-1. The potentiometer is eliminated and replaced with two push button selected decades, allowing five decade push button selection.

PT-3 Mechanically identical to the PT-2, i.e., uses five push button selected decades. Designed specifically for higher voltage inputs at the lower frequencies, necessarily restricting the high frequency range.



PT-2
Rack Mounted Model
(Typical)

*TM

3rd Edition

GERTSCH PRODUCTS, INC.

11846-48 Mississippi Avenue
Los Angeles 25, California
Phone BRadshaw 2-0568

MECHANICAL SPECIFICATIONS

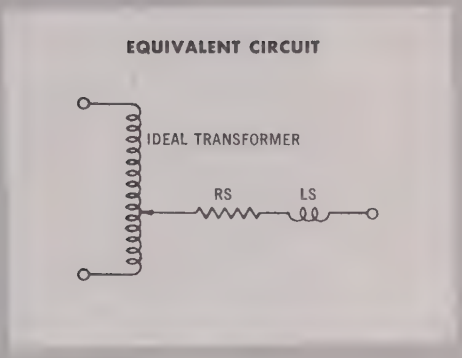
Each unit in the Series is available either with drawn aluminum carrying case (with removable front cover) or rack mounted (with protective dust cover). Rack mounted units can be supplied complete with aluminum case at additional charge. When ordering, specify carrying case type, rack mounted type, or rack mounted type with case.

	PT-1	PT-2	PT-3
DIMENSIONS	Rack 19 x 10½ x 4 in. Case 11 x 13 x 5¾ in.	Rack 19 x 10½ x 4 in. Case 11 x 13 x 9 in.	Rack 19 x 10½ x 9 in. Case 11 x 13 x 9 in.
WEIGHT	10 lbs.	13½ lbs.	22 lbs.

FRONT VIEW PT-3 (Cover Removed)

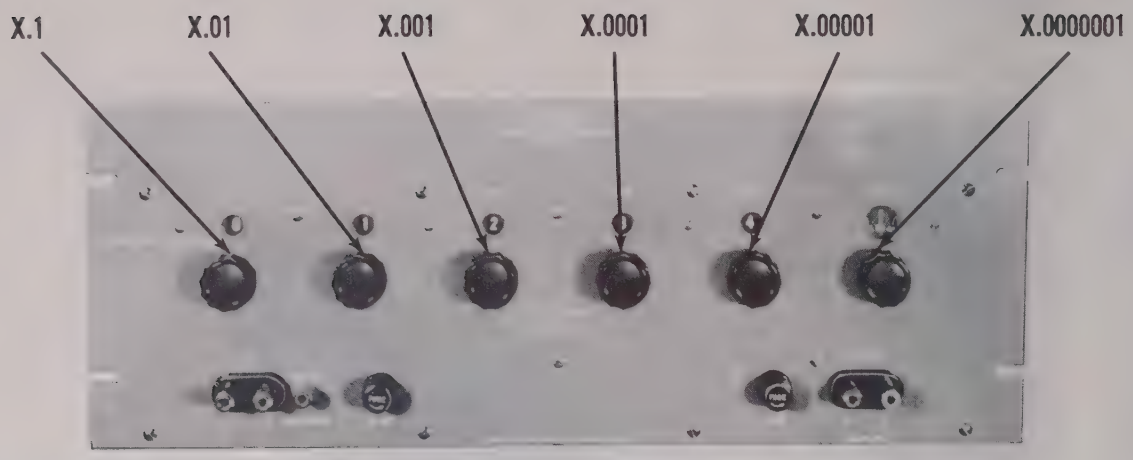
ELECTRICAL SPECIFICATIONS

Accuracy of Indicated Ratios (Loaded Condition): The accuracy is a function of the load applied. Assuming an Ideal Transformer looking into the arm we see an impedance (Ls and Rs) in series with the arm, which is due to leakage inductance, wiring resistance, switch resistance, potentiometer resistance and other stray circuit parameters. From these series impedances, the effect of loading upon the transformer and overall accuracy can be calculated. In the assumption of the Ideal Transformer the indicated unloaded accuracies apply at the arm of the assumed Ideal Transformer.

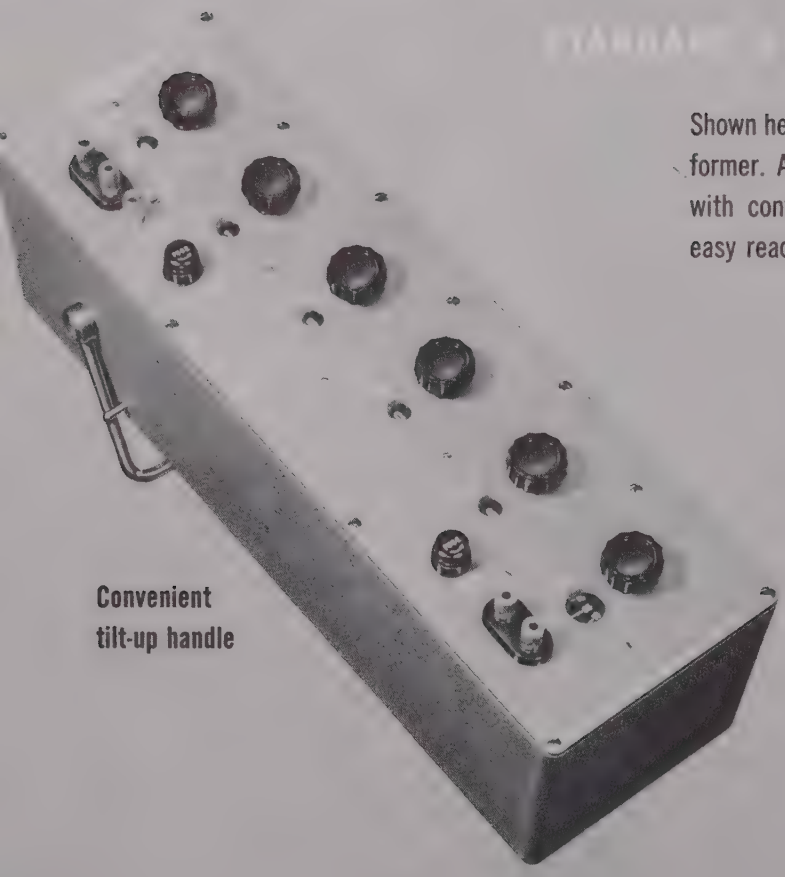


PERFORMANCE CHARACTERISTICS **RatioTran** (Unloaded)

	PT-1	PT-2	PT-3
Design Characteristics	Continuously Variable Output	Maximum Accuracy Min. Output Impedance	High Voltage at Low Frequency
Recommended Frequency Range	50-10,000 cps.	50-10,000 cps.	30-1000 cps.
Resolution % of Input	Continuous .0001% Divisions	.001% Steps	.001% Steps
Accuracy of Indicated Ratio 50 cps.—3 KC (PT-1 and PT-2) 30-1000 cps. (PT-3)	$\pm(.001\% + \frac{.0006\%}{R})$ Including Pot. $\pm(.004\% + \frac{.0001\%}{R})$ Pot. Set to Zero	$\pm(.001\% + \frac{.0001\%}{R})$	$\pm(.001\% + \frac{.0001\%}{R})$
Accuracy of Indicated Ratio 3.0-10 kc.	$\pm(.01\% + \frac{.0006\%}{R})$ Including Pot. $\pm(.01\% + \frac{.0001\%}{R})$ Pot. Set to Zero	$\pm(.01\% + \frac{.0001\%}{R})$	
Maximum Input Voltage ERMS Max.	.35f, f in CPS 350 volts above 1000 CPS	.35f, f in CPS 350 volts above 1000 CPS	2.5 f, f in CPS 350 volts above 140 CPS
Maximum Effective Series Resistance (RS)	12 ohms Ratio .545500 5 ohms Ratio .545000 (Transformer Only)	3 ohms	4 ohms
Maximum Effective Series Inductance (LS)	75 uh. max	75 uh. max	350 uh. max
Approximate Input Inductance	150 henries	150 henries	500 henries
Phase Angle (Unloaded)	Dependant upon frequency and ratio setting, but very small.		

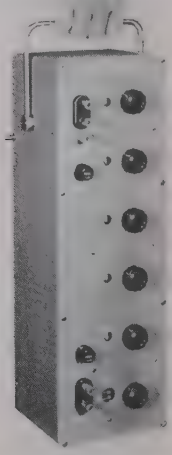


PT-5 shown above — typical Rack Mounted Model
PT-4 similar except for size (see dimensions)



Convenient tilt-up handle

Shown here are versions of the PT-5 Standard Ratio Transformer. Above, rack mounted model; below, case model with convenient new handle for either carrying or for easy reading in table position.



GERTSCH PRODUCTS, INC.

GENERAL DESCRIPTION

The PT-4 and PT-5 permit rapid selection of accurate voltage ratios by means of rotary switches . . . Two toroidally wound autotransformers are controlled by five decade switches followed by a single turn potentiometer, providing continuous resolution and readout of better than six significant figures . . . Ratio value is indicated as direct decimal reading . . . Every switch position displays its corresponding digit through a dust proof transparent window.

MECHANICAL SPECIFICATIONS

Each unit is available either in a cast aluminum case or rack mounted with cast aluminum dust cover. Carrying case models are provided with dual purpose handles. These may be used for carrying the instrument or for bench "Tilt-Up" operation. (See PT-5 photo).

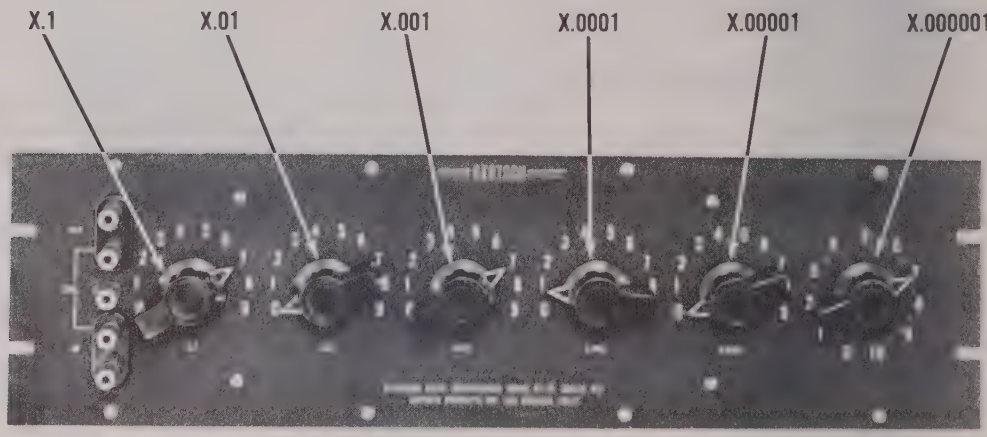
DIMENSIONS

	PT-4	PT-5
Case	17″ x 8¼″, 6¾″ high	17″ x 5¼″, 5½″ high
Rack	Std. 8¾″, 6⅜″ deep	Std. 7″, 5¼″ deep

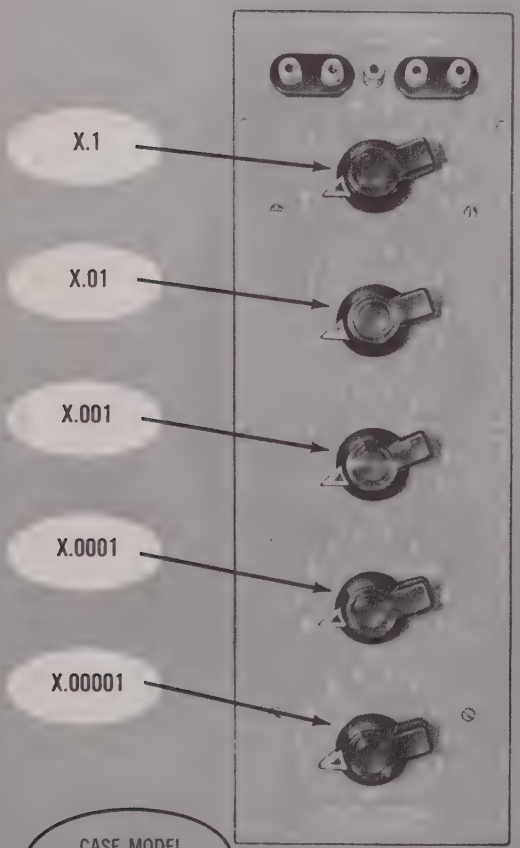
SPECIFICATIONS

	PT-4	PT-5
Design Characteristics	High Voltage Input at Low Frequencies	Maximum Accuracy Min. Output Impedance
Recommended Frequency Range	30-1,000 cps.	50-10,000 cps.
Resolution % of Input	Continuous	Continuous
Accuracy of Indicated Ratio 30-1, 000 cps (PT-4) 50-3,000 cps (PT-5)	$\pm(.001\% + \frac{.0001\%}{R})$	$\pm(.001\% + \frac{.0001\%}{R})$
Accuracy of Indicated Ratio 3-10 KC.		$\pm(.01\% + \frac{.0001\%}{R})$
Maximum Input Voltage ERMS max.	2.5 f, f in cps. 350 volts above 140 cps.	.35 f, f in cps. 350 volts above 1,000 cps.
Maximum Effective Series Resistance (RS)	4—ohms	3—ohms
Maximum Effective Series Inductance (LS)	350 uh.	75 uh.
Phase Angle (Unloaded)	Dependent upon frequency and ratio setting, but very small.	

HEAVY DUTY MODELS OF THE STANDARD RATIO TRANSFORMER



RACK
(Typ



CASE MODEL
(Typical)

The following RatioTran models have been designe
for unusually heavy service, such as production o
any continuous usage.

MECHANICAL SPECIFICATIONS

The PT-6, 7, 8 and 9 are available either with cast aluminum case (with "ti
up" handle) or rack mounted (with protective dust cover). When orderin
specify case or rack mounted type by adding the letter R to the rack ty
units, i.e., PT-6R. Supplied with standard blue — gray finish. Special finish
available upon request.

MODEL	DIMENSIONS	WEIGHT (Unpacked)
PT-6 (CASE)	15½"x5"x7" (high)	9 lbs.
PT-6R (RACK)	19"x5¼"x7" (deep)	10 lbs.
PT-7 (CASE)	15½"x5"x7" (high)	9.5 lbs.
PT-7R (RACK)	19"x5¼"x6⅝" (deep)	11 lbs.
PT-8 (CASE)	17⅛"x8⅜"x6½" (high)	24 lbs.
PT-8R (RACK)	19"x8¾"x7" (deep)	25 lbs.
PT-9 (CASE)	17⅛"x8⅜"x6½" (high)	24 lbs.
PT-9R (RACK)	19"x8¾"x7" (deep)	25 lbs.

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SPECIFICATIONS—HEAVY DUTY MODELS

	PT-6	PT-7	PT-8	PT-9
Design Characteristics	Maximum Accuracy Min. Output Impedance	Maximum Accuracy Min. Output Impedance	High Voltage Input at Low Frequencies	High Voltage Input at Low Frequencies
Recommended Frequency Range	50-10,000 cps.	50-10,000 cps.	30-1,000 cps.	30-1,000 cps.
Resolution % of Input	.001% steps	Continuous	.001% steps	Continuous
Accuracy of Indicated Ratio 30-1, 000 cps (PT-4) 50-3,000 cps (PT-5)	$\pm(.001\% + \frac{.0001\%}{R})$	$\pm(.001\% + \frac{.0001\%}{R})$	$\pm(.001\% + \frac{.0001\%}{R})$	$\pm(.001\% + \frac{.0001\%}{R})$
Accuracy of Indicated Ratio 3-10 KC.	$\pm(.01\% + \frac{.0001\%}{R})$	$\pm(.01\% + \frac{.0001\%}{R})$		
Maximum Input Voltage ERMS max.	.35 f, f in cps. 350 volts above 1,000 cps.	.35 f, f in cps. 350 volts above 1,000 cps.	2.5 f, f in cps. 350 volts above 140 cps.	2.5 f, f in cps. 350 volts above 140 cps.
Maximum Effective Series Resistance (RS)	2 ohms	3—ohms	3 ohms	4—ohms
Maximum Effective Series Inductance (LS)	75 uh.	75 uh.	350 uh.	350 uh.
Approximate Input Inductance	150 henries	150 henries	500 henries	500 henries
Phase Angle (Unloaded)	Dependant upon frequency and ratio setting, but very small.			

SUMMARY OF MODELS PT 1 - PT 9

The various models of Standard Ratio Transformers have been designed to cover specific applications.

Electrically, all models are basically the same. The principle differences are in mechanical construction and such details as the type of switch, number of decades, degree of resolution, maximum input voltage allowable, form factor and other details sometimes important to the user.

The following table has been prepared, segregating the units into two basic classifications, according to their electrical performance, to aid the user in selecting the proper unit for his particular applications. For more detailed information regarding a particular unit, please refer to the preceding tables and specific information.

LOW VOLTAGE, HIGH FREQUENCY GROUP

Maximum RMS input voltage .35 × F (350 volts max.) F = frequency in cps.
Input inductance 150 henries (approx.)

Model No.	Switch Type	No. of Decades	Significant Figures of Resolution	Type of Potentiometer	Remarks
PT-1	Push Button	3	6	10 turn	Three decade unit with 10 turn potentiometer. Utilizes push button switches. For low voltage input over wide frequency range. Calibrations engraved on push buttons. Best general instrument where moderate accuracy is required.
PT-2	Push Button	5	5	None	Five decade unit. No potentiometer. For low voltage, wide frequency range use. Calibrations engraved on push buttons.
PT-5	Rotary	5	6	1 Turn	Five decade unit with one turn potentiometer. Extremely good resolution. Calibration available through window in panel. Best general purpose instrument where low voltage input, high resolution and wide frequency range are important factors.
PT-6	Rotary (Heavy Duty)	5	5	None	Five decade unit. No potentiometer. For low voltage, wide frequency use. Contains heavy duty, rotary switches with calibration screened on front panel.
PT-7	Rotary (Heavy Duty)	5	6	1 Turn	Five decades and one turn potentiometer. Extremely good resolution. For low voltage wide frequency range use. Calibrations screened on front panel. Heavy duty rotary switches.

HIGH INPUT VOLTAGE, LOW FREQUENCY GROUP

Maximum input voltage, 2.5 × F (350 volts max.) F = frequency in cps.
Input inductance 500 henries. (Approx.)

Model No.	Switch Type	No. of Decades	Significant Figures of Resolution	Type of Potentiometer	Remarks
PT-3	Push Button	5	5	None	Five decade unit. No potentiometer. For high voltage, low frequency use. Calibrations engraved on push-buttons.
PT-4	Rotary	5	6	1 Turn	Five decade unit with one turn potentiometer. Rotary switches with calibration on front panel. For high voltage low frequency use.
PT-8	Rotary (Heavy Duty)	5	5	None	Five decades, no potentiometer. For high voltage, low frequency use. Heavy duty rotary switches with calibration on front panel.
PT-9	Rotary (Heavy Duty)	5	6	1 Turn	Five decade unit with one turn potentiometer. Heavy duty rotary switches. Calibration on front panel. For high voltage, low frequency use.

RatioTran* Model 10
STANDARD RATIO TRANSFORMER

The RatioTran Model 10 is a precision AC voltage divider designed for minimum panel space of only 3½" in height. Input and output connections are on both front and rear. It features an easy readout system and employs three decades and a ten-turn potentiometer. Input and output are both fused to protect the transformer against overload and the chassis has removable dust cover.

The Gertsch Standard Ratio Transformers (RatioTran*) are precision AC voltage dividers. Their inherent characteristics of high input impedance, low output impedance, and very low phase shift, are factors which all engineers will recognize as necessary for a good AC voltage divider. Their performance approaches that of the ideal divider. For the division of AC voltages they are superior to resistance type dividers.

Their unique construction "builds in" certain performance factors which are very advantageous when these units are used separately, or incorporated into a systems design. Some of these desirable features are: (1) Extreme accuracy, and ability to maintain their accuracy. They are basically ageless devices. (2) Insensitivity to thermal changes. They will operate properly over the range of -15°C +80°C. (3) They are not appreciably affected by change of altitude, or humidity, and will withstand both shock and vibration, unless of a very severe nature.

APPLICATIONS: Use as the ratio arm of a bridge, an AC potentiometer, for checking resolvers, servos, transformers, computers, etc. Also useful for meter calibration and as a standard of ratio. *For more complete applications ask for Gertsch Engineering Bulletins on RatioTrans**

SPECIFICATIONS RatioTran Model 10

Design characteristics	Continuously variable output
Switch type	Rotary, normal duty
Recommended frequency range	50 - 10,000 cps
Maximum input voltage (E_{RMS})	.35 x frequency, max. 350 V (f in cps)
Resolution	.00005 % 3 decades and 10 turn potentiometer
Accuracy of indicated ratio 50 cps - 3 kc	$\pm(.001\% + \frac{.0006\%}{R})$
3 kc - 10 kc	$\pm(.01\% + \frac{.0006\%}{R})$ R = indicated ratio
Terminal linearity	.001%
Maximum effective series impedance	R_S - 12 ohms max. L_S - 75 microhenries max.
Approximate input inductance	150 henries
Phase angle unloaded	Dependant upon frequency and ratio setting, but very small
Dimensions	Rack panel, 3½" high 19" long 4½" deep
Connections	Input and output available both front and rear
Shipping weight	20 pounds, approx.

ACCURACY OF INDICATED RATIOS (Loaded Condition):

The accuracy is a function of the load applied. Assuming an ideal transformer looking into the arm we see an impedance (Ls and Rs) in series with the arm which is due to leakage inductance, winding resistance, switch resistance, potentiometer resistance and other stray circuit parameters. From these series impedances, the effect of loading upon the transformer and overall accuracy can be calculated. In the assumption of the Ideal Transformer the indicated unloaded accuracies apply at the arm of the assumed Ideal Transformer.

EQUIVALENT CIRCUIT

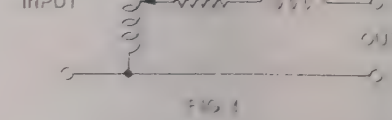


FIG. 1

*Trademark

RatioTran* Model 11
STANDARD RATIO TRANSFORMER

The RatioTran Model 11 is a heavy duty precision AC tage divider with ruggedized switches of solid silver l other features to withstand heavy usage. It has been igned for minimum panel space (3½" high). Input l output connections are on both front and rear. It tures an easy, improved readout system and employs e decades and a one-turn potentiometer. Input and put are both fused to protect the transformer against rload and the chassis has a removable dust cover.

The Gertsch Standard Ratio Transformers (Ratio-n*) are precision AC voltage dividers. Their inherent racteristics of high input impedance, low output im-ance, and very low phase shift, are factors which all ineers will recognize as necessary for a good AC tage divider. Their performance approaches that of ideal divider. For the division of AC voltages they superior to resistance type dividers.

Their unique construction "builds in" certain performance factors which are very advantageous when these units are used separately, or incorporated into a systems design. Some of these desirable features are: (1) Extreme accuracy, and ability to maintain their accuracy. They are basically ageless devices. (2) Insensitivity to thermal changes. They will operate properly over the range of -15°C + 80°C. (3) They are not appreciably affected by change of altitude, or humidity, and will withstand both shock and vibration, unless of a very severe nature.

APPLICATIONS: Use as the ratio arm of a bridge, an AC potentiometer, for checking resolvers, servos, transformers, computers, etc. Also useful for meter calibration and as a standard of ratio. *For more complete applications, ask for Gertsch Engineering Bulletins on RatioTrans®.*

PECIFICATIONS RatioTran Model 11

Design characteristics	Continuously variable output, high accuracy, heavy duty.
Switch type	Rotary, heavy duty
Recommended frequency range	50 - 10,000 cps
Maximum input voltage (E_{RMS})	.35 x frequency, max. 350 V (f in cps)
Resolution	.00001 % 5 decades and 1 turn potentiometer
Accuracy of indicated ratio 50 cps - 3 kc	$\pm(.001\% + \frac{.0001\%}{R})$
3 kc - 10 kc	$\pm(.01\% + \frac{.0001\%}{R})$ R = indicated ratio
Terminal linearity	.001%
Maximum effective series impedance	R_S - 3 ohms max. L_S - 75 microhenries max.
Approximate input inductance	150 henries
Phase angle unloaded	Dependant upon frequency and ratio setting, but very small
Dimensions	Rack panel, 3½" high 19" long 7¼" deep
Connections	Input and output available both front and rear
Shipping weight	20 pounds, approx.

ACCURACY OF INDICATED RATIOS (Loaded Condition):

The accuracy is a function of the load applied. Assuming an ideal transformer looking into the arm we see an impedance (Ls and Rs) in series with the arm, which is due to leakage inductance, wiring resistance, switch resistance, potentiometer resistance and other stray circuit parameters. From these series impedances, the effect of loading upon the transformer and overall accuracy can be calculated. In the assumption of the Ideal Transformer the indicated unloaded accuracies apply at the arm of the assumed Ideal Transformer.

EQUIVALENT CIRCUIT

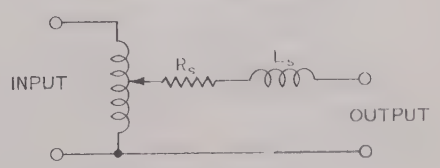


FIG. 1

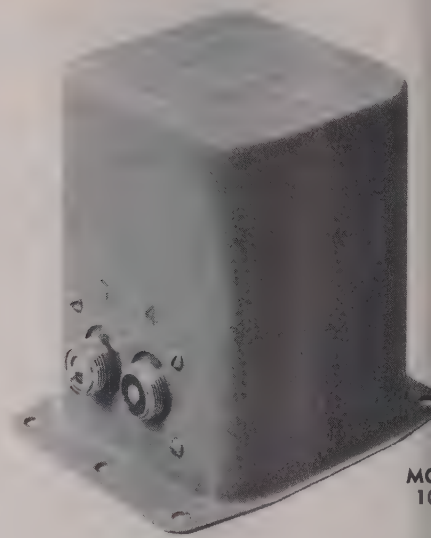
*Trademark

Special Purpose TRANSFORMERS

BRIDGE TRANSFORMERS

The Models 100 and 100A Double Shielded Transformers have been designed for use with the Gertsch Standard Ratio Transformers, to isolate the Null Detector from the Bridge. They also may be used in AC bridges, to isolate the Detector or Generator from the measuring network, or to provide a balanced output from an unbalanced generator. Other applications of Gertsch Bridge Transformers include use as step-up or step-down, or wherever isolation is desired.

In both models, each winding is individually shielded. In the Model 100A, the terminals are also shielded, resulting in complete electrostatic shielding of each winding. Also, a mu metal shield has been included to reduce the external hum pick-up to a minimum.



SPECIFICATIONS

	MODEL 100	MODEL 100A
Turns ratio	4 to 1	4 to 1
Intershield capacitance	less than 25 mmf	less than 30 mmf
Frequency range	20 - 5,000 cps	20 - 5,000 cps
DC Resistance, Lo Z	80 ohms	80 ohms
Hi Z	1800 ohms	1800 ohms
Insulation	500 V. test	500 V. test
Input voltage	115 V. at 60 cps*	115 V. at 60 cps*
Height	4 5/16"	4 5/16"
Width (with mounting)	3 11/16"	3 11/16"
Depth (without terminals)	4 1/2"	4 1/2"
Depth (with terminals)	4 7/8"	7 5/8"
* Into Hi Z winding for impedance larger than 100 Ohms across low Z winding		

UNITY RATIO PHASE INVERTING TRANSFORMER - Model 200

Designed for use with Gertsch Standard Ratio Transformers, to provide a phase shift of 180° to the input or output of the Ratio Transformer in certain bridge applications. No shields are supplied around windings. Use with one winding floating is not recommended.

SPECIFICATIONS

Turns ratio:	1 to 1
Effective winding resistance:	10 ohms
Effective leakage inductance:	2.5 mh
Open circuit ratio accuracy:	.005%
Open circuit phase error:	less than .03 milliradian at 400 cps
Voltage into windings:	E_{rms} Max. = .35 f (f is frequency in cps) not to exceed 170 V. RMS
Height:	4 5/16"
Width:	3 11/16"
Depth (without terminals):	4 1/2"
Depth (with terminals):	4 7/8"

The following Engineering Bulletins are available, covering the theory and application of RatioTrans. They can be obtained by writing Gertsch Products, Inc., 11846 Mississippi Avenue, Los Angeles 25, California, Attn: Sales Dept.

Engineering Bulletin No. 1 (RatioTran)
"Theoretical Analysis of Accuracy of Ratio Transformers"

Engineering Bulletin No. 2 (RatioTran)
"Use of Gertsch Standard Ratio Transformers for Low Impedance Voltmeter Calibration"

Engineering Bulletin No. 3 (RatioTran)
"Accuracy Calculations for Gertsch Standard Ratio Transformers"

Engineering Bulletin No. 4 (RatioTran)
"Use of RatioTran in Bridge Circuits"

Engineering Bulletin No. 5 (RatioTran)
"Measuring Small Phase Angles"

Additional bulletins are being prepared and will be made available as soon as possible.

The following prices apply, as of June 1, 1956, to the various RatioTran Models. These prices are subject to change without notice. Those models with the letter "R" are rack type with the exception of the Models 10 and 11 which are rack only.

PT-1 ..... $330.00	PT-3R $540.00	PT-6 ..... $450.00	PT-8R $550.00
PT-1R 330.00	PT-4 ..... 540.00	PT-6R 450.00	PT-9 ..... 590.00
PT-2 ..... 400.00	PT-4R 540.00	PT-7 ..... 455.00	PT-9R 590.00
PT-2R 400.00	PT-5 ..... 400.00	PT-7R 455.00	Model 10 ..... 295.00
PT-3 ..... 540.00	PT-5R 400.00	PT-8 ..... 550.00	Model 11 ..... 470.00

ALBUQUERQUE, NEW MEXICO
Neely Enterprises
107 Washington St., S.E.
Albuquerque 5-5586

ATLANTA, GEORGIA
Bivins & Caldwell
3133 Maple Drive
CHerokee 7522

BALTIMORE, MARYLAND
Horman Associates, Inc.
635 St. Johns Road

CHICAGO 40, ILLINOIS
Alfred Crossley & Assoc.
4501 No. Ravenswood Ave.
UPtown 8-1141

CLEVELAND, OHIO
S. Sterling Co.
4311 Mayfield Rd.
EVergreen 2-4114

DALLAS 9, TEXAS
Earl Lipscomb Assoc.
3605 Inwood Rd.
P. O. Box 7084
ELmhurst 5345

DAYTON 9, OHIO
Alfred Crossley & Assoc.
53 Park Avenue
OXmoor 3594

DENVER, COLORADO
Hytronic Measurement Assoc.
446 Broadway
SHerman 4-2501

DETROIT, MICHIGAN
S. Sterling Company
15310 W. McNichols Road
BRoadway 3-2900

FORT MEYERS, FLORIDA
Arthur H. Lynch Assoc.
P. O. Box 466
Fort Myers 5-6762

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Harris-Hanson Co.
7916 Paseo Avenue
Hiland 4-6744

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Neely Enterprises
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North Hollywood, Calif.
STanley 7-0721 - POplar 6-3811

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Gerard Zeegers
Prado Sur 820
Mexico 10, D. F.

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P. O. Box 569
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GIlbert 4-0878
NY Phone: REctor 2-0091

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CRestview 4-5431

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Ron Merritt Company
1238 N. W. Glisan St.
BRoadway 1281

SACRAMENTO, CALIFORNIA
Neely Enterprises
1317 15th Street
GIlbert 2-8901

SAN DIEGO, CALIFORNIA
Neely Enterprises
1029 Rosecrans Street
ACademy 3-8106

SAN FRANCISCO, CALIFORNIA
Neely Enterprises
2830 Geary Blvd.
WAlnut 1-2361

SEATTLE, WASHINGTON
Ron Merritt Company
120 W. Thomas Street
GArfield 6644

ST. LOUIS, MISSOURI
Harris-Hanson Company
2814 So. Brentwood Blvd.
MIssion 7-4350

ST. PAUL, MINNESOTA
Alfred Crossley & Assoc.
2388 University Avenue
MIdway 5-4955

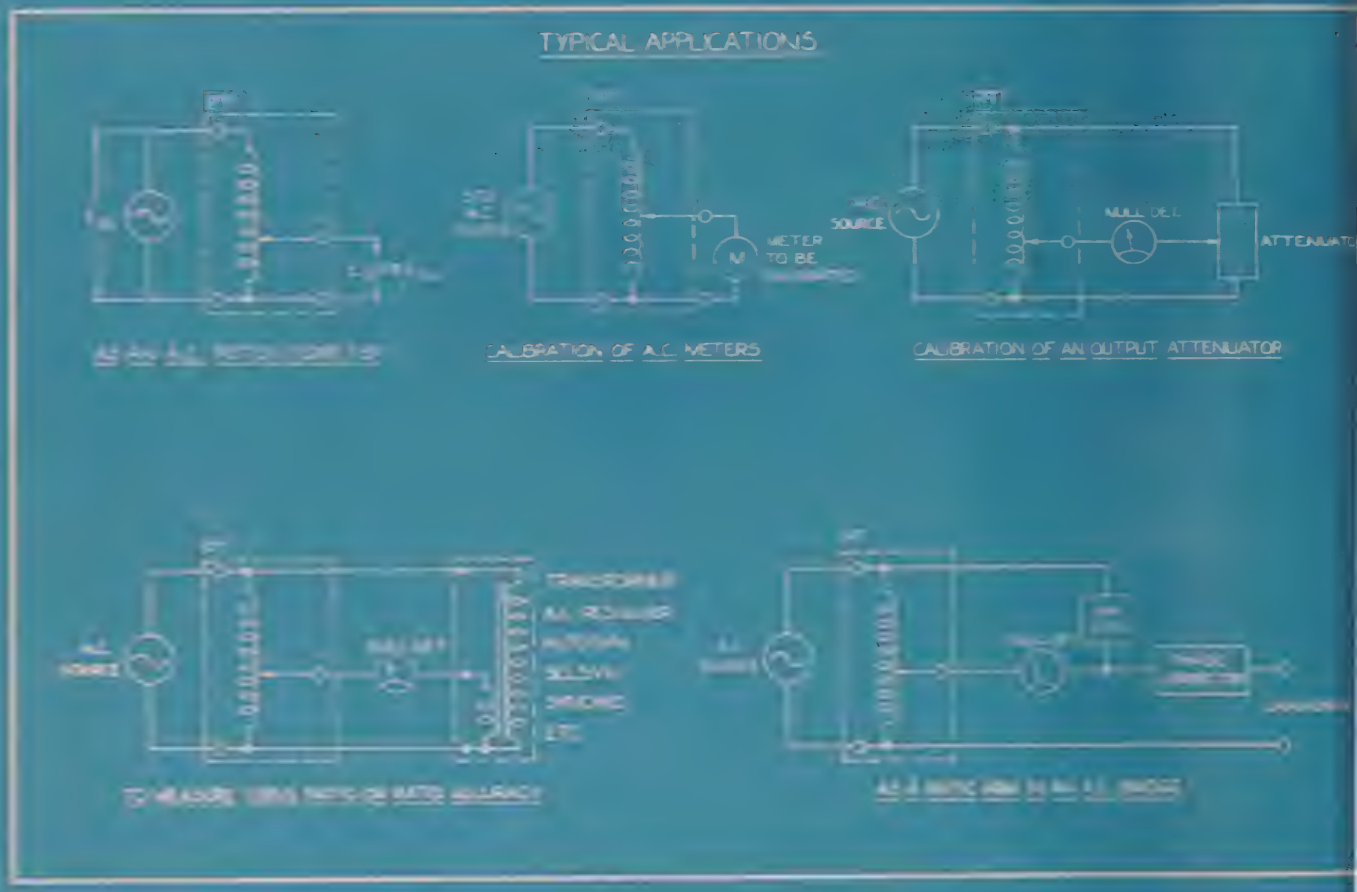
SYRACUSE, NEW YORK
J. D. Ryerson Assoc., Inc.
412 E. Genesee St.
SYracuse 76-8344

WASHINGTON, D. C.
Horman Assoc., Inc.
2017 "S" Street, N. W.
DEcatur 2-5707

TORONTO, ONTARIO, CANADA
Atlas Radio Corp., Ltd.
50 Wingold Ave.
RUssell 1-6174

EXPORT AGENT
Sylvan Ginsbury
8 W. 40th St.
New York 18, New York
PEnnsylvania 6-8239

TYPICAL APPLICATIONS



other bridge applications. For applications which require 180° phase shift at unity voltage ratio, the Gertsch Model [illegible] is also available. For further information concerning the Model 1000A and Model [illegible] see Gertsch brochure illustrating those items.

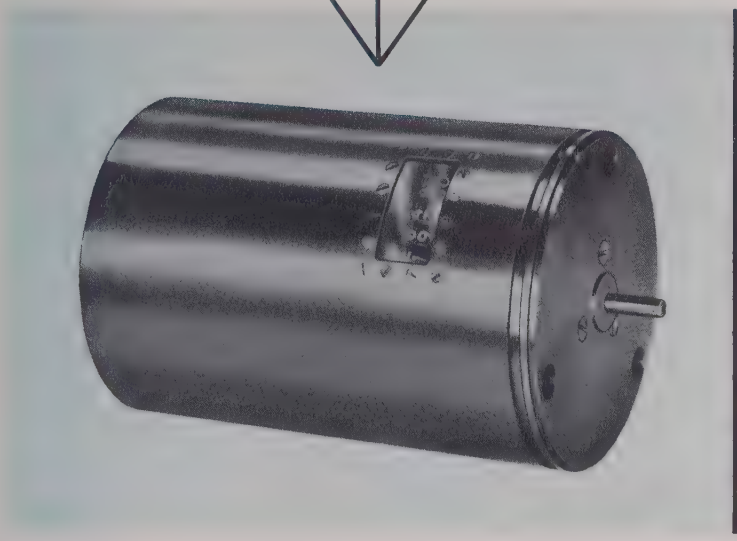
FOR FURTHER INFORMATION REGARDING RATIOMANS AND OTHER GERTSCH PRODUCTS, CONTACT THE FACTORY OR YOUR NEAREST GERTSCH ENGINEERING REPRESENTATIVE.

REPRESENTED BY:

GERTSCH

MODELS 302 AND 303

a new sealed shaft-driven precision AC voltage divider for accurate positioning and calibration



ROTARY

RatioTran*

- HIGH ACCURACY
- HIGH RESOLUTION
- LOW PHASE SHIFT
- HIGH INPUT IMPEDANCE
- LOW OUTPUT IMPEDANCE
- TRANSIENT FREE OUTPUT

The newest in the complete line of Gertsch RatioTran* precision AC voltage dividers is this sealed, rotary unit available in either 100-turn or 1000-turn models. Terminal linearity of the 100-turn (Model 303) is .01% and of the 1000-turn (Model 302) is .005%.

The Gertsch Standard Ratio Transformers (RatioTran) are precision AC voltage dividers. Their inherent characteristics of high input impedance, low output impedance, and very low phase shift, are factors which all engineers will recognize as necessary for a good AC voltage divider. Their performance approaches that of the ideal divider.

In the Models 302 and 303, ratio is controlled by a single shaft. An internal mechanical counter provides for simplified readout.

Printed silver switches and precious metal wipers assure long life and reliability. Shaft is precision ground quarter inch diameter mounted in ball bearings.

These new RatioTran models are, as with all Gertsch Standard Ratio Transformers, not appreciably affected by change of altitude or humidity, and will withstand both shock and vibration, unless of a very extreme nature.

*Trademark

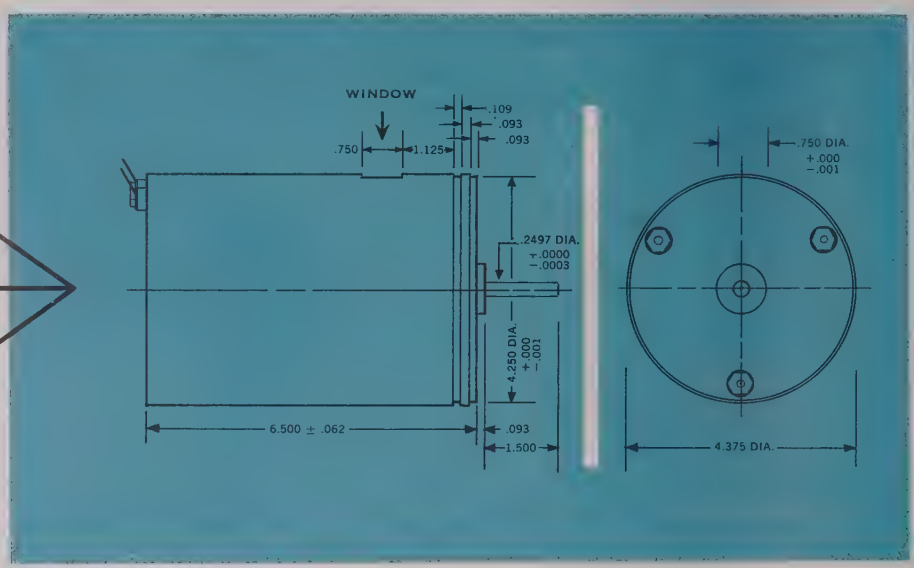
GERTSCH PRODUCTS, INC.

11846-48 Mississippi Avenue
Los Angeles 25, California

SHAFT-DRIVEN ROTARY RATIOTRAN

Dimensions of both the Model 302 and 303 are shown at the right. They are enclosed in a sealed anodized aluminum case. The built-in counter is sealed behind a glass window.

DIMENSIONS



SPECIFICATIONS		
	Model 303	**Model 302**
Number of turns for ratios .000 to 1.000	100	1000
Electrical rotation	39594 degrees	395994 degrees
Mechanical rotation	39594 degrees	395994 degrees
Range of ratio	−.05 to +1.05 continuous through 0 and 1	−.05 to +1.05 continuous through 0 and 1
Linearity	.01%	.005%
Resolution	.005%	.0005%
Output impedance	30 ohms max.	30 ohms max.
Input impedance	Approx. 50 henrys	Approx. 200 henrys
Input voltage	.35f (f in cps) 350 volts max.	.7f (f in cps) 350 volts max.
Frequency range	50-2000 cps	50-2000 cps
Phase shift	Less than 1′	Less than 1′
Dimensions	See drawing above	See drawing above
Weight	4.5 pounds	4.5 pounds
Readout	Built-in counter	Built-in counter
Mounting	Servo rim or screw	Servo rim or screw
Rotational speed (max.)	400 rpm	400 rpm

GERTSCH PRODUCTS, INC.
1345-48 Mississippi Avenue
Los Angeles 25, California

THEORETICAL ANALYSIS OF ACCURACY OF RATIO TRANSFORMERS (RatioTran)*

Theoretical analysis of a perfect autotransformer used for stepdown purposes shows that if leakage inductance and winding resistance are uniformly distributed and the turns can be accurately tapped, the accuracy as a voltage divider for no load is perfect.

Consider first the effects of leakage inductance. The most symmetric configuration insofar as flux is concerned is the uniformly wound toroid. By suitably interleaving the windings and carefully maintaining uniformity, the total leakage inductance can be kept to under 10% of the air core inductance. Since the air core inductance is approximately 1/u times the inductance with iron core, where u is the permeability of the core material, the total leakage inductance to coupled inductance ratio is 1/10u. The core material used in the transformers is supermalloy which has a guaranteed initial permeability of 55,000. The leakage to coupled inductance ratio is therefore approximately .0002%. Since this figure represents the ratio of voltage dropped in the leakage inductance to total voltage, the error in the transformer due to non-distributed leakage inductance will not exceed this, if the leakage inductance per turn does not vary by more than ±100%. This condition can be met with suitable techniques of interleaving the windings.

Non-distributed winding resistance has much the same effect as non-distributed leakage inductance. If the effects of winding capacitance are neglected, the winding resistance is most important at low frequencies since the exciting impedance of the transformer is directly proportional to frequency. Since the exciting impedance is fairly reactive, the voltage dropped in the winding resistance will be almost in quadrature with the input and consequently any non-distributed resistance will cause some phase error as well as magnitude error. The fact that this error voltage is in quadrature makes the magnitude error extremely small and for all practical purposes negligible. Typical figures might be .000001% for small ratios and even less for larger ratios. Phase angles from this cause would be approximately .01 milliradians at low frequencies and small ratios decreasing for larger ratios.

At higher frequencies distributed capacitance becomes important. It causes voltage drops in the leakage inductance and winding resistance which are not uniformly distributed due to the transformer action. Like the effects of winding resistance, the errors caused by the capacitance are mainly in quadrature and so cause phase shift at low ratios. Typical values for this phase shift are:

Less than .05 milliradians for frequencies below 1 KC and ratios above .1 for low voltage - high frequency units.

Less than .05 milliradians for frequencies below 200 cps and ratios above .1 for high voltage low frequency units.

Phase angle due to this cause is almost directly proportional to frequency for any particular ratio down to frequencies where the non-distributed resistance takes over.

Other sources of error are:

1. Voltage drops due to exciting current in the leads to the transformer.
2. Loading effects of the potentiometers.
3. Non-linearity and end effects of the potentiometer.

The first of these effects may be minimized by using heavy connecting leads or treating the transformer as a four terminal impedance. The internal wiring of the transformers contributes to this error. These effects are worse at higher frequencies, above the self-resonant frequencies of the transformers.

The potentiometers cause some loading effects on the transformers due to the internal impedances of the windings and switch contacts.

For units with the 10 turn potentiometer, such as the PT1 and Model 10, the errors due to this cause are approximately .0001% of the input. In the single turn units this error amounts to about .00001%. The single turn potentiometer causes less error than the 10 turn since the voltage across it is .001% of the input in comparison to .1% across the 10 turn potentiometer.

Non-linearity and end effects of the potentiometer may cause an error of approximately .0005% of the input in the case of the units with the 10 turn potentiometers. The single turn potentiometers may cause an error of .00001% of the input.

From the foregoing considerations a reasonable terminal linearity figure of .001% is derived. The usual definition of terminal linearity is the error in the output divided by the total input:

$$\text{Terminal Linearity} = \frac{\triangle E_o}{E_{IN}}$$

where $\triangle E_o$ is the actual error voltage in the output and E_{IN} is the total input voltage.

An accuracy figure in terms of the output voltage would be

$$\text{Ratio Accuracy} = \frac{\triangle E_o}{E_o}$$

where $\triangle E_o$ is the actual error voltage in the output and E_o is the total output voltage.

When the ratio gets small, the error caused by pot loading, pot non-linearity, and lead drops become predominant. Since these errors are constant in absolute value, their fractional value in terms of the output is inversly proportional to the ratio of the transformer. Taking this into account a reasonable ratio accuracy for the three decade units with the 10 turn pot is:

$$\text{Ratio Accuracy} \pm \left(.001\% + \frac{.0006\%}{R}\right)$$

(This applies to Models PT1 and 10) and for the 5 decade units, with or without the single turn pot:

$$\text{Ratio Accuracy} \pm \left(.001\% + \frac{.0001\%}{R}\right)$$

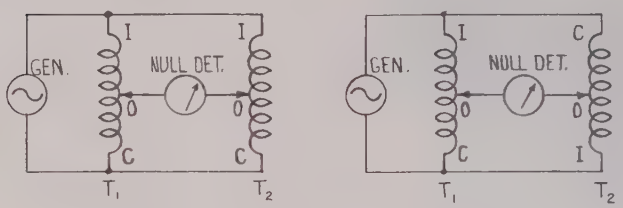
where R is the indicated ratio of the transformer. (This applies to all Models except PT1 and 10)

Standards suitable for certifying transformers to the accuracy figures quoted are not generally available. It can be seen, however, from the foregoing discussions that the transformers are inherently excellent voltage dividers. They can be considered primary standards of ratio in that one can be constructed by following assembly instructions and requiring no measurements or calibrations other than wiring checks and tests to make certain that the number of turns is correct. A unit so constructed will match any other unit so constructed to well within the specifications

*TM

quoted above. The units are ageless, requiring no calibration tests and should perform indefinitely with no loss in accuracy barring some switch failure or actual damage to the transformer.

Tests have been performed on a basis of comparison between several units. While it is not possible to get complete absolute data in this manner, certain facts can be deduced. Referring to the diagram T_1 and T_2 represent the two transformers under test.



Let R_1 be indicated ratio of T_1
R_2 be indicated ratio of T_2

Let E_1 be error in indicated Ratio of T_1
E_2 be error in indicated Ratio of T_2

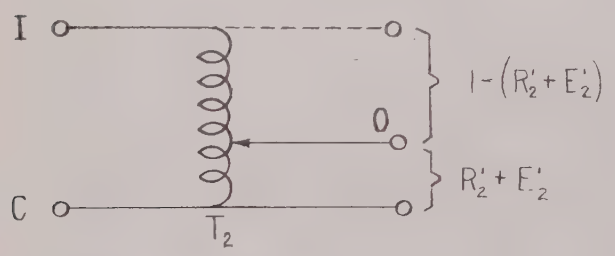
then at balance in Test 1

$R_1 + E_1 = R_2 + E_2$

at Balance in Test 2

$R_1 + E_1 = 1 - (R_2' + E_2')$

where $1 - (R_2' + E_2')$ is the complement of $R_2' + E_2'$ as shown below



Now suppose that in both tests

$R_1 = R_2$

$R_1 = 1 - R_2'$

then $E_1 = E_2$

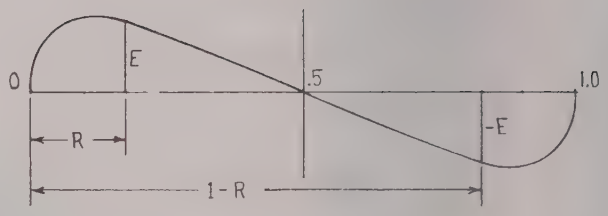
$E_2' = -E_1$

or $E_2' = -E_2$

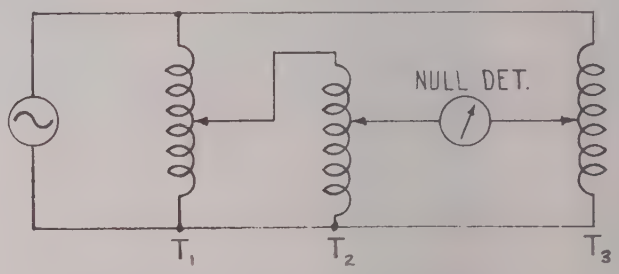
This shows that if at balance in both tests the indicated are exactly equal or complementary there can exist an error of a special nature which cannot be detected.

E at R = -E at (1-R)

E must be zero at R = .5 and show odd symmetry about R = .5



In general, any two transformers so tested will meet the conditions for the tests within 1 or 2 parts in 10^6 so that any components of error which do not show the above symmetry must be at least this small. To obtain some idea of the absolute errors two transformers were cascaded and compared against a third as shown below.



$(R_1 + E_1)\ (R_2 + E_2) = (R_3 + E_3)$ at Balance

if we choose $R_1 = R_2 = .5$

from the foregoing analysis $E_1 \quad E_2 \quad 0$

If proper care is taken to compensate for loading effects the magnitude of E_3 can be determined at $R_3 \quad .25$. This error in general is less than .001%.

This process can be continued by cascading more transformers and measuring the error at points $R = (.5)^N$

It is easy to show that the same analysis applies to quadrature voltage. The same tests can be made and values of 0 at points $R = (.5)^N$ determined. The phase angle data given earlier in this article was derived in this manner.

All of the foregoing discussions apply to completely unloaded conditions on the transformers. Effects of loading are discussed in Engineering Bulletin No. 3 entitled "Accuracy Calculations for Gertsch Standard Ratio Transformers."

Accuracy formulas given above apply only to those units shipped after January 1, 1956. Previous units have accuracies of $\pm(.004\% + \frac{.0006\%}{R})$ and $\pm(.004\% + \frac{.0001\%}{R})$ respectively.

5/14/56

USE OF GERTSCH STANDARD RATIO TRANSFORMERS (RatioTran*) FOR LOW IMPEDANCE VOLTMETER CALIBRATION

The PT Series Standard Ratio Transformers are very useful for AC voltmeter calibrations. Basically, the system consists of a standard voltage source driving the RatioTran which in turn drives the meter to be calibrated.

Several things must be taken into consideration in this system. The source voltage must be known at least as accurately as the calibration to be made. The distortion of the source must be low, particularly in a case where the meter which is monitoring the source measures on a different basis from the meter to be calibrated. For example, the monitoring meter might read RMS voltage and the meter to be calibrated might read average voltage.

The loading effects of the meter to be calibrated on the RatioTran should be taken into consideration. These loading effects can be easily determined from the ratio of meter impedance to ratio transformer impedance. For all practical purposes the ratio transformer impedance is resistive and forms, with the meter to be calibrated, a voltage divider. Therefore, if the voltmeter is resistive, the voltage appearing across it will be low by an amount equal to the ratio between the RatioTran resistance and the meter resistance. For example, if the RatioTran has an internal impedance of 5 ohms and the meter has a resistance of 5,000 ohms, the voltage appearing across the meter will be 5/5000 or .1% lower than it would be if the meter had infinite impedance.

The foregoing analysis can be generalized. The fractional error that will exist with the RatioTran resistance R and meter resistance M is approximately equal to $\frac{R}{M}$, or stating it a different way, for a maximum error E the meter resistance M must be greater than $\frac{R}{E}$, where R is again the series impedance of the RatioTran.

The maximum series impedance in any of the ratio transformers for nominal frequencies is less than 5 ohms with the exception of the PT-1 (and Model 10) where the maximum is 12 ohms. Consequently, for meter impedance of 5,000 ohms or greater the error introduced by loading effects on the ratio transformers will not be greater than .1% for all ratio transformers except the PT-1 and Model 10, in which case for the same accuracy the meter resistance must not be less than 12,000 ohms.

If greater accuracies are desired or the meter impedance is lower than the values given above, power must be supplied to the meter in a bridge arrangement shown in Figure 1. With this circuit it is possible to adjust the variable series impedance so that all the power supplied to the meter comes from this branch. This, of course, occurs when the bridge is balanced, that is, the ratio of the meter impedance to the total impedance (meter impedance plus variable impedance) is equal to the ratio of the Standard Ratio Transformer. Obviously, when the bridge is balanced there is no current flow through the ratio arm of the transformer and the junction between the series impedance and the meter so there is effectively no load on the ratio transformer.

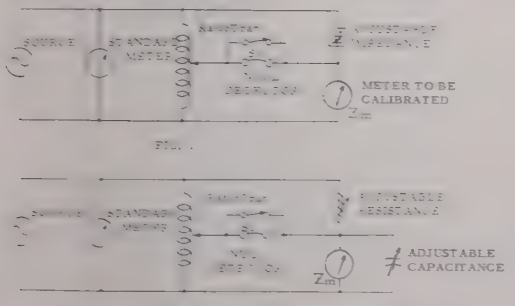


FIG. 1A
Modification of Fig. 1
CONVENIENT WHEN Z_m CONTAINS INDUCTIVE REACTANCE

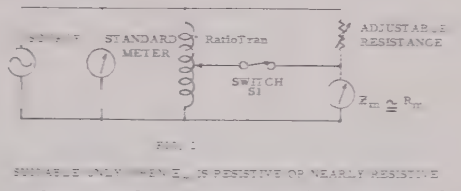
Since we can make the ratio transformer operate essentially unloaded by this method, meters with impedance as low as desired can be calibrated with no loss in accuracy.

One other restriction must be placed on the variable impedance in series with the meter. It must have the same phase angle as the meter. The total requirement can be stated generally as follows: the ratio of the complex impedances of a meter and series impedance must be real and equal to $\frac{N}{1-N}$ where N is the ratio on the ratio transformer. Here we have assumed that the Ratio Transformer has zero phase shift.

This last statement is merely another way of saying that the bridge formed must be balanced.

The degree of unbalance which can be tolerated in the bridge circuit can best be expressed in terms of the unbalanced current flowing in the ratio arm of the transformer. Since the product of the unbalanced current times the effective impedance in the ratio arm gives the magnitude of the error voltage, the maximum value of this current can be easily determined. It would be simply E Max. divided by R Max. where E is the maximum allowable error voltage and R is the maximum series impedance in the ratio arm of the transformer.

The unbalanced current itself may be measured directly with a high sensitivity AC current meter, or the bridge may be brought to balance with standard null detector techniques. The null detector should be shorted out with switch, S1, after balance has been reached. This last step is recommended since the voltage at the junction between the series impedance and the meter will always be closer to the true voltage for small errors if the null detector is shorted out.



SUITABLE ONLY WHEN Z_m IS RESISTIVE OR NEARLY RESISTIVE

If the phase angle of the meter is known to be small this series impedance may be resistive and balance of the bridge can be detected with a circuit shown in Figure 2. The switch, S_1, is alternately opened and closed and the series impedance adjusted so that the meter reads the same whether the switch is opened or closed. When this occurs the bridge is balanced provided the phase angle of the meter is small. The phase angle requirement must be met because it is possible, in this test, for the meter to read the same whether the switch is opened or closed and still not have the voltage across it equal to the open circuit voltage of the ratio transformer, when the phase angle of the meter in the series impedance are not equal. The allowable phase angle can be determined from the circuit constants and the accuracy desired, or a direct measurement of the unbalanced current may be made.

For maximum accuracy of calibration the RatioTran should not be used to divide the standard source too far. The reason for this is, the accuracy of the ratio decreases for small ratios between output and input of the RatioTran. To guarantee accuracies better than .02% it would be necessary to operate with ratios larger than .01. To extend the system range below .01 a new standard voltage one 100th the original standard voltage could be derived with the RatioTran and this used to extend the system on down by another factor of 100. In this manner a total range of 10,000 to 1 can be covered with less than .04% error. One method of doing this is to connect two ratio transformers in cascade. The percentage errors of the two transformers can be added in this case.

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5/8/56

ACCURACY CALCULATIONS FOR GERTSCH STANDARD RATIO TRANSFORMERS (RatioTran*)

1. DEFINITION

The accuracy of Gertsch Standard Ratio Transformers is specified by a formula which gives the maximum error which could be expected in the indicated ratio. This would give the error as a percentage of the output if the input is perfectly known. This accuracy is applicable to a bridge circuit, since the source voltage is common to both branches of the bridge circuit and variations of source voltage cause no error. The accuracy specification is given as a formula similar to $\pm\ (.004\% + \frac{.0001\%}{R})$ where R is the indicated ratio in the decimal fraction form with which the RatioTran switches are calibrated. This formula gives a more accurate description of the maximum error which could be expected from a Gertsch RatioTran than would be obtained by the standard definition of terminal linearity. In a potentiometer terminal linearity rating, the error component which is to be expected at the output is quoted as a percentage of the input voltage. A comparison of the specified maximum error in a RatioTran and a potentiometer of .005% terminal linearity is given in the following table.

ERROR EXPRESSED AS PERCENTAGE OF OUTPUT			
Ratio	Ratio Transformer Units Shipped Prior to 1/1/56 $\pm(.004\% + \frac{.0001\%}{R})$	Ratio Transformer Units Shipped After 1/1/56 $\pm(.001\% + \frac{.0001\%}{R})$	Potentiometer .005% Terminal Linearity
1.0	± .0041%*	± .0011%*	± .005%
.1	± .005%	± .002%	± .05%
.01	± .014%	± .011%*	± .5%
.001	± .104%*	± .101%*	± 5%

*This is the exact solution of the formula. Since "error" is only roughly specified, all digits beyond the first significant figure are meaningless.

2. ACCURACY vs AGE

A careful study of the distribution of resistance and reactance in RatioTrans leads us to believe that it is extremely improbable that the specified values of error will ever be exceeded. The accuracy of Gertsch RatioTrans does not change appreciably with age and periodic calibration checks are unnecessary. Any periodic checks should be directed chiefly at detecting malfunctioning switches or potentiometers.

3. ACCURACY UNDER LOAD

Gertsch Standard Ratio Transformers have an internal impedance which can be considered to be in series with the output (see Fig. 1).

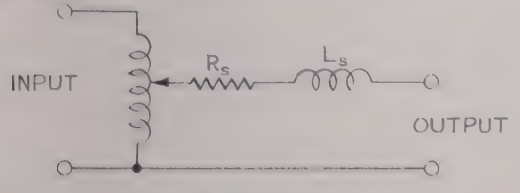

FIG. 1

The value of this impedance varies with ratio in a manner which makes it impractical to define it as a function of ratio. Instead, maximum values of resistance and reactance that can be expected at the worst possible setting of the instrument are given. Voltage drop in the RatioTran will always be less than the value found by multiplying the load current by the specified maximum series impedance. If the impedance of the load is known, the error introduced by this impedance will always be less than the ratio of the specified maximum impedance to the load. As a numerical example, suppose that a 10,000 ohm resistive load is to be driven from a Model PT-5 operating at 400 cycles. The PT-5 has a maximum effective series inductance of 75 uh. At 400 cycles this is an inductive reactance of .2 ohms, and, for the purposes of this problem, it may be neglected since it is much less than the 3 ohms maximum effective series resistance. The PT-5 may be assumed to have a series impedance of 3 ohms or less resistive. When loaded by 10,000 ohms, the fraction of output voltage dropped across the internal impedance of the PT-5 is given by:

$$\frac{Edrop}{Eout} = \frac{Rseries}{Rload + Rseries} = \frac{3}{10{,}000 + 3} \simeq \frac{3}{10{,}000} = .0003 = .03\%$$

In this case the percentage error contributed from this source is .03%. If this error is acceptable, the circuit may be used. Otherwise a bridge circuit must be devised which will drive the required load impedance without loading the Ratio Transformer beyond the acceptable current level. Circuits for this purpose are discussed in another paper distributed by Gertsch Products, Inc. The title of this paper is Engineering Bulletin No. 2 (RatioTran) "Use of Gertsch Standard Ratio Transformers For Low Impedance Voltmeter Calibration."

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5/8/56

USE OF RatioTran IN BRIDGE CIRCUITS

Since any bridge circuit has four terminals, only one of which may be grounded, it is recommended that a shielded bridge transformer such as the Gertsch Model 100 or 100A be used to isolate either the generator or detector. Typical circuits are shown below.

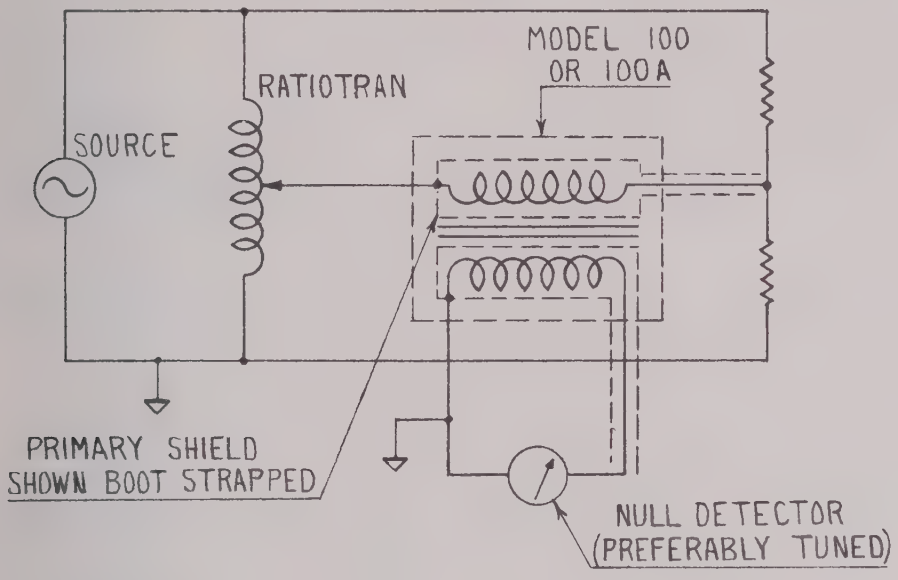

FIG. 1

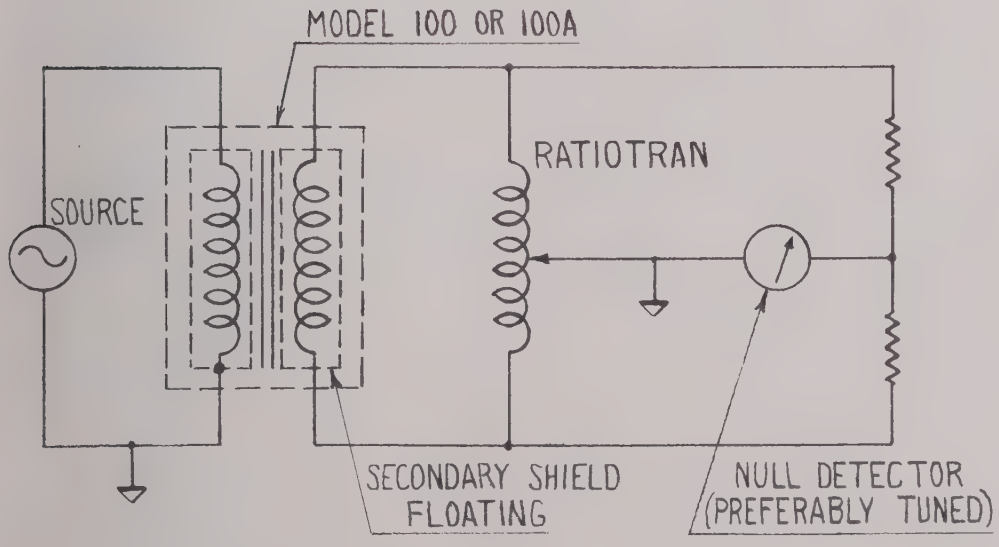

FIG. 2

The degree of shielding of the various bridge elements used depends on impedances and accuracy desired. For a good treatment on AC Bridge technique the reader is referred to "Electronic Measurements" - Terman & Pettit.

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5/14/56

The following article originally appeared in the January 1956 issue of Control Engineering and is reprinted here with the permission of Control Engineering and the author, Mr. Jack Gilbert.

Measuring Small Phase Angles

JACK GILBERT, Norden Laboratories

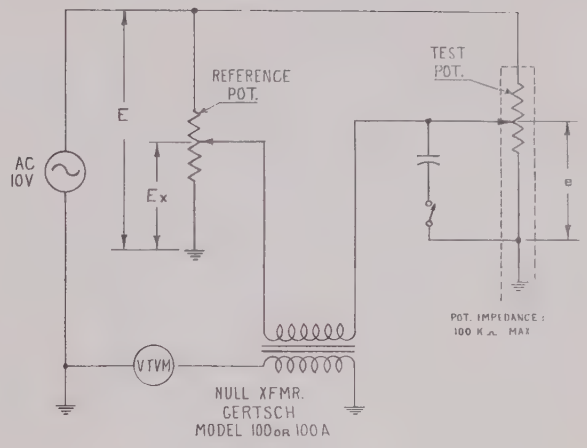

FIG. 1

Phase shift due to potentiometers, precision resistors, computer amplifiers, ac tachometers, and transformer windings can be found by a relatively simple technique that can measure phase angles as small as 0.005 deg and as large as 30 deg. With some loss of accuracy, angles up to 90 deg can also be detected by the method. The detection circuit, with elements of only conventional accuracy, obtains phase shift and quadrature voltage from a reference voltage varying from 50 to 5,000 cps. And the result is accurate to plus or minus 0.01 deg plus or minus 5 per cent at midband (350—1000 cps).

The reference voltage, E, is divided by the reference pot slider until a minimum or null reading is observed on the vacuum tube voltmeter. This voltmeter reading will be the quadrature voltage. The phase shift created by the reference pot is insignificant because of its relatively low impedance and internal construction. Figure 1 illustrates the circuit and Figure 2 its theory of operation.

The voltage ratio X is read directly from the dial of the reference pot, and the null voltage from the meter. An infinite resolution slide-wire type pot is desirable for

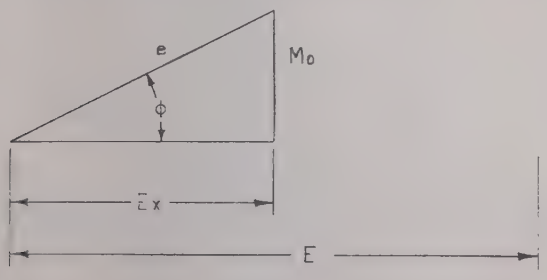

FIG. 2

the reference voltage divider. The phase shift is an angle whose tangent is equal to Mo/EX. For angles less than 6 deg, multiply the ratio Mo/EX by 57.3 deg to calculate a phase angle within the accuracy of the measurement technique. If a constant reference source is used, the dial of the voltmeter can be calibrated in phase shift directly.

It will be noted that as the phase angle becomes smaller, variations in EX produce an increasingly greater role in the variations of Mo. Hence, the accuracy of the technique for small angles is exceeded by its sensitivity. To achieve the indicated accuracy of 5 per cent, the reference pot should be accurate to ¼ per cent for angles less than 1 deg and the meter calibrated within 3 per cent.

For potentiometers, a small capacitor may be switched across the test component to determine the polarity (lead or lag) of the shift. The change in meter reading is then indicative of the polarity of the phase angle. For instance, if the shift is caused by capacitative reactance of the tested part, the condenser will augment them, increasing the negative phase shift and hence the null voltage. Similar techniques may be used for other components.

A plot of the phase shift of an unloaded ten-turn potentiometer can be easily calculated once its time con-

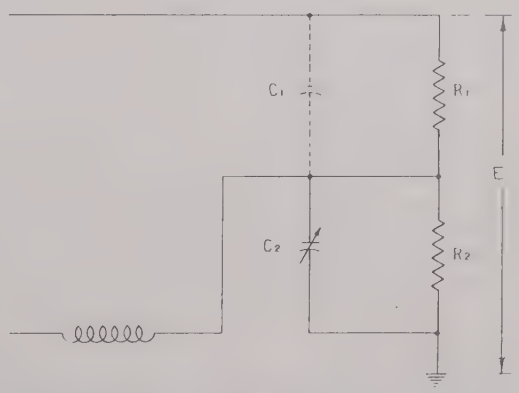

FIG. 3

*TM

stant is known. The time constant could be found by suitable calculation involving the phase shift measurements (obtainable by the balancing technique), but here is a direct way of finding it.

Figure 3 shows the setup R_1 is the entire ten-turn pot. R_1C_1 is the time constant produced by the distributed capacity of the pot. C_2 is a variable capacitor, and R_2 a small fixed resistor of approximately the same resistance as the pot. The phase shift through this resistor is too small to be significant. Only when the adjustable capacitor, C_2 is such that R_2C_2 equals R_1C_1 is the output voltage in phase with the input voltage. With the reference pot set near its halfway point, the in-phase component of the voltage will equal the voltage EX, but will be out of phase with EX depending on the time constant of R_1C_1.

This time constant can now be used in the following equation to find the quadrature voltage of any of the ten-turn pot's shaft settings.

$$Mo = EwRC\ (1-2S)\ (1-S)\ (S)$$

E = input voltage
w = radian frequency
R = potentiometer overall resistance
C = equivalent lumped capacity measured across end terminals
S = shaft position, in per cent of maximum rotation.

Similarly, one can calculate phase shift (in radians) by

$$\varnothing = wRC\ (1-2S)\ (1-S)$$

Since similar expressions can be derived for other pot types, one reading provides all the information needed to plot a pot's phase shift characteristics.

Rather than a slide-wire pot, an ideal standard voltage divider is a Gertsch Ratio Standard, Model PT-5. Resolution better than 0.0001 per cent is available together with a voltage ratio accurate to within 0.004 per cent. The advantage of this item is accurate output with very low internal impedance and extremely low phase shift.

The following additional information is supplied by the Engineering Department of Gertsch Products, Inc.

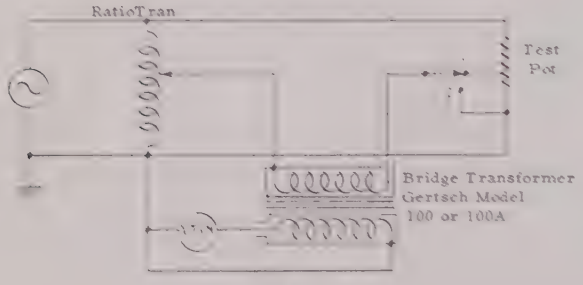

FIG. A

The circuit shown in Fig. A is a variation on the method described in the preceding article. Leads may be changed instead of using a switch.

In operation, the RatioTran is adjusted to the best null with the switch in position 1. The RatioTran then reads the inphase component of voltage ratio. The VTVM is read and the switch thrown to position 2. The RatioTran is then adjusted to bring the VTVM back to the same reading. The RatioTran then reads the quadrature component of the unknown ratio. This method has the advantage of eliminating errors from the null transformer voltage ratio. Also, the source voltage need not be accurately known.

A possible source of error when measuring phase angles by this method is the loading on the bridge caused by the null transformer and null detector. The method depends on measuring the remaining voltage at the best null. This voltage will be reduced because of current through the primary of the null transformer. Unless the impedance of the device under test is low compared to the impedance of the null transformer primary, the error will be serious. The circuit of Fig. B can be used to reduce this effect since a high impedance VTVM may be used directly as a null detector.

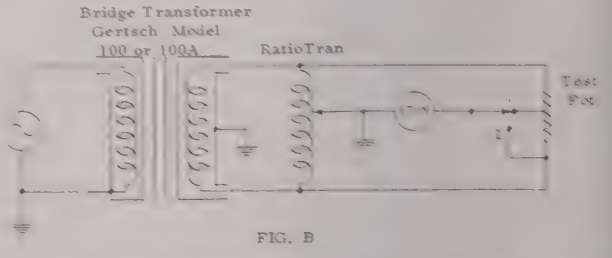

FIG. B

The bridge transformer may be omitted in this circuit if the source is capable of satisfactory operation as a floating source.

Partial List of Users

GERTSCH STANDARD RATIO TRANSFORMERS
RATIOTRAN®

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Bell Aircraft Corp.
Boeing Airplane Co.
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- San Diego, California

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4-30-56

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CONTACT THE FACTORY OR YOUR NEAREST GERTSCH ENGINEERING REPRESENTATIVE.

REPRESENTED BY:

GERTSCH

SHORT FORM CATALOG #2

CISION ELECTRONIC INSTRUMENTS

Frequency Measuring Equipment

L.F. through Microwave, 100 kilocycles to 12,500 megacycles

Standard Ratio Transformers

AC voltage dividers, capable of extreme accuracy and resolution in measurement and generation of AC voltage ratios

Peak Reading Volt Meters

Wide band, peak reading vacuum tube voltmeters

Deviation Meters

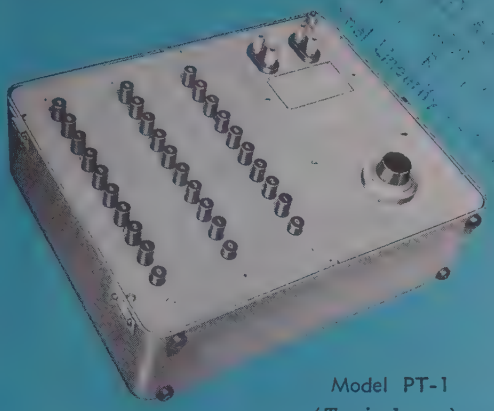
Completely transistorized Peak Modulation Deviation Meters, continuous coverage from 20 to 640 mc.

Special Purpose Transformers

Bridge Transformers and Unity Ratio Phase Inverting Transformers designed for use with Standard Ratio Transformers

PRECISION ELECTRONIC INSTRUMENTS

Gertsch Products, Inc., 11846 Mississippi Avenue, Los Angeles 25, Calif., BRadshaw 2-0568



Model PT-1
(*Typical case*)

Model PT-7R
(*Typical rack*)

Model PT-3
(*Typical case*)

Model PT-5
(*Typical tilt-up*)

AC VOLTAGE DIVIDERS

Precision auto-transformers (AC voltage dividers) capable of extreme accuracy and resolution in the measurement and generation of AC voltage ratios. Nine different models are available to cover specific applications. Electrically, all models are basically the same. The principle differences are in mechanical construction and such details as the type of switch, number of decades, degree of resolution, maximum input voltage allowable, form factor, and other details shown below. The PT-1, 2, 5, 6, and 7 are low voltage, high frequency models. The PT-3, 4, 8, and 9 are high input voltage, low frequency models. Case and rack models are available for all types. All accuracy specifications given below are under no load conditions. All PT units are usable outside their indicated frequency range with reduced accuracy.

PT-1 Ratio can be set by means of 3 decade switches and a ten turn potentiometer. Push button.
Accuracy ± $\left(.004\% + \frac{.0006\%}{R}\right)$ where R is ratio.
Range 50 to 3000 cps. **$330.00**

PT-2 Same as PT-1 except potentiometer is replaced with 2 extra decade switches.
Accuracy ± $\left(.004\% + \frac{.0001\%}{R}\right)$.
Range is 50 to 3000 cps. **$400.00**

PT-3 Same as PT-2, except for higher voltage at lower frequencies. Particularly useful at 60 cycles.
Accuracy ± $\left(.004\% + \frac{.0001\%}{R}\right)$.
Range is 30 to 1000 cps. **$540.00**

PT-4 5 decade, rotary switches and a one-turn potentiometer. Accuracy ± $\left(.004\% + \frac{.0001\%}{R}\right)$
Range 30 to 1000 cps. **$540.00**

PT-5 5 decade, rotary switches and a one-turn potentiometer.
Accuracy ± $\left(.004\% + \frac{.0001\%}{R}\right)$.
Range 50 to 3000 cps. **$400.00**

PT-6 Heavy duty ruggedized model. Five decade, rotary switches, no potentiometer.
Accuracy ± $\left(.004\% + \frac{.0001\%}{R}\right)$.
Range 50 to 3000 cps. **$450.00**

PT-7 Heavy duty ruggedized model. Five decade, rotary switches, with one-turn potentiometer.
Accuracy ± $\left(.004\% + \frac{.0001\%}{R}\right)$.
Range 50 to 3000 cps. **$455.00**

PT-8 Heavy duty ruggedized model. Five decade, rotary switches, no potentiometer.
Accuracy ± $\left(.004\% + \frac{.0001\%}{R}\right)$.
Range 30 to 1000 cps. **$550.00**

PT-9 Heavy duty, rotary switch model. Five decade unit with one-turn potentiometer.
Accuracy ± $\left(.004\% + \frac{.0001\%}{R}\right)$.
Range 30 to 1000 cps. **$590.00**

IMPROVED ACCURACY

≤ (.001 ± .0001/R)

Terminal Linearity — 0.001%

LOW VOLTAGE, HIGH FREQUENCY GROUP

Maximum RMS input voltage .35 x F(350 volts max.) F=frequency in cps. — input inductance 150 henries (approx.)

Model No.	Switch Type	No. of Decades	Significant Figures of Resolution	Type of Potentiometer	Remarks
PT-1	Push Button	3	6	10 turn	Three decade unit with 10 turn potentiometer. Utilizes push button switches. For low voltage input over wide frequency range. Calibrations engraved on push buttons. Best general instrument where moderate accuracy is required.
PT-2	Push Button	5	5	None	Five decade unit. No potentiometer. For low voltage, wide frequency range use. Calibrations engraved on push buttons.
PT-5	Rotary	5	6	1 turn	Five decade unit with one turn potentiometer. Extremely good resolution. Calibration available through window in panel. Best general purpose instrument where low voltage input, high resolution and wide frequency range are important factors.
PT-6	Rotary (Heavy Duty)	5	5	None	Five decade unit. No potentiometer. For low voltage, wide frequency use. Contains heavy duty, rotary switches with calibration screened on front panel.
PT-7	Rotary (Heavy Duty)	5	6	1 turn	Five decades and one turn potentiometer. Extremely good resolution. For low voltage wide frequency range use. Calibrations screened on front panel. Heavy duty rotary switches.

HIGH INPUT VOLTAGE, LOW FREQUENCY GROUP

Maximum input voltage, 2.5 x F(350 volts max.) F=frequency in cps. — Input inductance 500 henries. (approx.)

Model No.	Switch Type	No. of Decades	Significant Figures of Resolution	Type of Potentiometer	Remarks
PT-3	Push Button	5	5	None	Five decade unit. No potentiometer. For high voltage, low frequency use. Calibrations engraved on push-buttons.
PT-4	Rotary	5	6	1 turn	Five decade unit with one turn potentiometer. Rotary switches with calibration same as PT-5. For high voltage low frequency use.
PT-8	Rotary (Heavy Duty)	5	5	None	Five decades, no potentiometer. For high voltage, low frequency use. Heavy duty rotary switches with calibration on front panel.
PT-9	Rotary (Heavy Duty)	5	6	1 turn	Five decade unit with one turn potentiometer. Heavy duty rotary switches. Calibration on front panel. For high voltage, low frequency use.

PEAK DEVIATION METER

DM-1

peak modulation deviation meter

(shown installed in FM-3)

The DM-1 fits into the lower compartment of the FM-3 Frequency Meter, making one single portable package capable of measuring and generating carrier frequencies PLUS reading peak modulation deviation with continuous coverage from 20 to 640 megacycles. The DM-1 is a completely transistorized unit, with a deviation range of 15 kc. full scale.

Accuracy of deviation measurement: 5% of full scale
Sensitivity: less than .1 volt required for satisfactory limiting at any frequency in the range.

Ruggedized design using miniature components and self-contained transistor-type batteries. Low power consumption plus automatic cut-off switch provide unusually long battery life. Stabilized for wide temperature range. Phone jack for monitoring. DM-1 only, **$375.00.** FM-3/DM-1 in portable carrying case, **$1117.50.** The DM-1 is also available, as a separate item, in drawn aluminum carrying case with cover, DM1-C, at **$405.00** and Rack mounted, DM1-R at **$400.00.**

PEAK VOLTMETER

VM-1

peak reading vacuum tube voltmeter

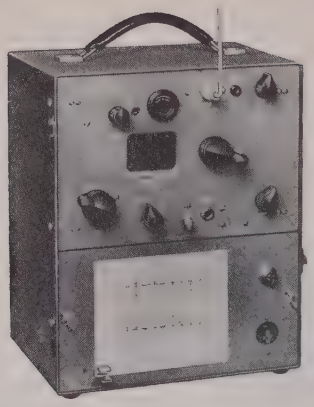
The Model VM-1 is a true Peak Reading Vacuum Tube Voltmeter, designed to measure either postive peak, negative peak, or peak to peak voltage of repeated pulses with very short duty cycles. The instrument comes complete with probe.

Basic range is 1-100 volts full scale. Accuracy of the basic instrument is 3% of full scale. Accuracy with multipliers is 5% of full scale.

The following multipliers are available:

VM1-A .....300 volt
VM1-B .....1000 volt
VM1-C .....3000 volt
VM1-D .....10 and 30 kv

Model VM-1 ..... **$405.00**
Model VM1-A, B, C **55.25**
Model VM1-D **205.00**



FM-3

VHF FREQUENCY METER - FM-3

Direct reading VHF frequency meter, known as the standard of the industry. Extremely accurate and stable units (.001%), designed for measurement and generation of frequencies. Basic frequency range is 20 to 40 mc. Using harmonics, the FM-3 will measure and generate frequencies from 20 to 640 mc. and up to 1000 mc. under certain conditions, with continuous coverage over the entire range. Also frequencies down to 1 mc. can be measured. May be used to set peak deviation on FM transmitters.

Direct reading, with no calibration book necessary. Exceeds FCC requirements for accuracy and stability. May be standardized against W.W.V. Internal 1 kc. modulation. Available in convenient portable case with handle, or for rack mounting.

Model FM-3 (battery operated)	$687.50
Model FM-3/PS-3 (AC power operated)	742.50
Model FM-3R (rack mounted - without cabinet)	764.50
Model FM-3R (rack mounted - with case)	794.50
Model PS-3 Power Supply	50.00
Model PS-3C Power Supply	55.00

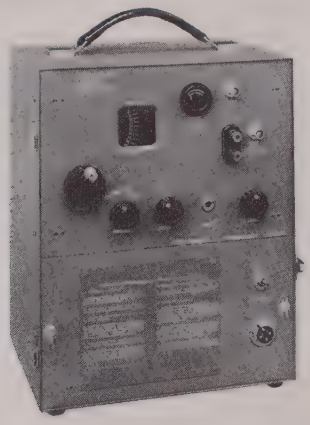
FM-4

MICROWAVE FREQUENCY MULTIPLIER - FM-4

Capable of measuring and generating frequencies in the UHF and microwave regions with a high degree of accuracy. It requires an auxiliary driving source such as the FM-3 or the AM-1 shown on this page. Basic frequency range is 500 to 1000 mc. Using harmonics, it will measure and generate frequencies from 500 to 12,500 megacycles with continuous coverage. Using special techniques, operation well above 12,500 mc. can be obtained. It will measure frequencies down to 100 mc.

The accuracy and stability is primarily a function of the driving unit For example, when driven by the FM-3, the accuracy and stability are .001%. When driven by the AM-1, with proper auxiliary equipment, accuracy and stability are as good as .00001%.

Model FM-4 (shown)	$1,650.00
Model FM-4R (rack mounted)	1,650.00



FM-5

FREQUENCY DIVIDER - FM-5

The Model FM-5, when driven by a VHF frequency meter, is capable of measuring or generating frequencies in the "low" through "high" frequencies with a high degree of accuracy. It is designed specifically to extend the frequency measuring range of either the FM-3 or AM-1 down to 50 kc. and the frequency generating range down to 200 kc. with no loss in accuracy. Measures and generates up to 20 mc. with continuous coverage.

Accuracy and stability of the FM-5, when driven by the FM-3, is .001%. When used with the AM-1, and suitable auxiliary equipment, accuracy and stability are .00001%.

Model FM-5 (shown)	$425.00
Model FM-5/PS-3 (AC power operated)	485.00
Model FM-5R (rack mounted model with metal case)	530.00
Model FM-5R (rack mounted model without metal case)	500.00

AM-1

VHF INTERPOLATOR - AM-1

Auxiliary equipment designed primarily to extend the range of existing frequency standards. Using harmonics, it is capable of measuring and generating any frequency within the range of 20 to 1000 mc. It requires, for operation, (1) input from a 100 kc. standard and (2) equipment to measure accurately frequencies between 1 and 2 megacycles, such as a counter.

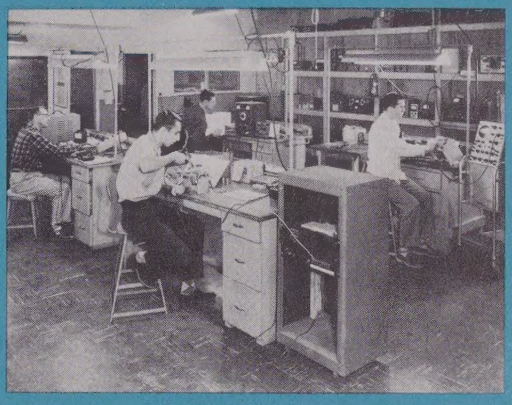
Its accuracy and stability are primarily a function of the 100 kc. source and the 1 to 2 mc. measuring equipment. Accuracies as good as 1 part in 10^7 (1 cycle in 10 megacycles) can be obtained. Ultimate accuracy approaches 1 part in 10^8.

Model AM-1	$1,500.00

GERTSCH

where skilled engineering produces precision performance

At Gertsch Products, we devote all of our time to the development and production of precision electronic instruments. Almost a quarter of our plant area and a full complement of engineers and scientists are employed in constant research and development of new devices which will provide the engineer with better development instruments and the production line with more adequate test equipment. Before we ever produce a new instrument it is first tested completely in our own plant, then field tested to be sure its operation meets the original specifications.

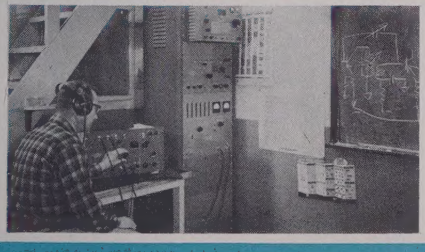


DESIGNING NEW INSTRUMENTS

Our engineering staff spends many months on the design of new equipment before putting it into actual production. The staff is made up of qualified engineers, with experience in all types of electronic equipment. Each member has had research and development experience as well as production experience.

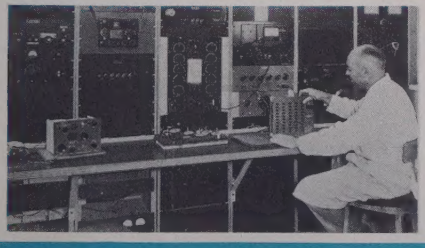
PERFECTING PRESENT INSTRUMENTS

The Gertsch line of precision electronic instruments is relatively small, but it is complete in each category. Our Frequency Meter line, started with only one instrument, has now grown to four, with variations in specifications and physical make-up of each available to fit every conceivable requirement. Our Standard Ratio Transformer line includes nine models and each is available in several case configurations.



PLANNING NEW TECHNIQUES

We are in constant touch with the industry's new developments and work them into present production of listed instruments as well as in the devices being planned. Newest techniques, use of transistors, and the ruggedization of equipment have been incorporated in the present Gertsch instruments. Many more are in the planning stages.



PRODUCING QUALITY EQUIPMENT

Our engineering department has developed a complete set of test equipment for checking all Gertsch instruments produced. It is a complete test rack and is capable of testing our regular schedule of production as well as almost any special instruments which we might be called upon to produce. In-line tests are made of all sub-assemblies. Incoming inspection is made on a 100% basis for all critical items.

● BRIDGE TRANSFORMERS

The Models 100 and 100A Double Shielded Transformers have been designed for use with the Gertsch Standard Ratio Transformers, to isolate the Null Detector from the Bridge. They also may be used in AC bridges, to isolate the Detector or Generator from the measuring network, or to provide a balanced output from an unbalanced generator. Other applications of Gertsch Bridge Transformers include use as step-up or step-down, or wherever isolation is desired.

In both models, each winding is individually shielded. In the Model 100A, the terminals are also shielded, resulting in complete electrostatic shielding of each winding. The 100A also has a mu metal shield to reduce the external hum pick-up to a minimum.

Model 100 ..... **$36.00**

Model 100A **85.00**

Specifications:

	MODEL 100	MODEL 100A
Turns ratio	4 to 1	4 to 1
Intershield capacitance	less than 25mmf	less than 30 mmf
Frequency range	20 - 5,000 cps	20 - 5,000 cps
DC Resistance, Lo Z	80 ohms	80 ohms
Hi Z	1800 ohms	1800 ohms
Insulation	500 V. test	500 V. test
Input voltage	115V. at 60 cps*	115V. at 60 cps*
Height	4 5/16"	4 5/16"
Width (with mounting)	3 11/16"	3 11/16"
Depth (without terminals)	4 1/2"	4 1/2"
Depth (with terminals)	4 7/8"	7 5/8"

* Into Hi Z winding for impedance larger than 100 Ohms across low Z winding

● UNITY RATIO PHASE INVERTING TRANSFORMERS

Model 200 designed for use with Gertsch Standard Ratio Transformers, to provide a phase shift of 180° to the input or output of the Ratio Transformer in certain bridge applications. No shields are supplied around windings. Use with one winding floating is not recommended.

Model 200 ..... **$54.00**

SPECIFICATIONS

Turns ratio:	1 to 1
Effective winding resistance:	10 Ohms
Effective leakage inductance:	2.5 mh
Open circuit ratio accuracy:	.005%
Open circuit phase error:	less than .03 milliradian at 400 cps
Voltage into windings:	E Max. = .35 f (f is frequency in cps) not to exceed 170 V. RMS
Height:	4 5/16"
Width:	3 11/16"
Depth (without terminals):	4 1/2"
Depth (with terminals):	4 7/8"

● VOLTMETER CALIBRATION TRANSFORMERS

Model 201. Designed for calibrating vacuum tube voltmeters. **Input:** 300 volts RMS. 400 cps. **Outputs:** (V RMS) 300, 100, 30, 10, 3, 1.440 (equals 2.037 volts peak which is equal to 2 standard cells in series), 1.0, .8, .6, .4, .3, .2, .1, .03, .01, .003, .001. Accuracy of voltage ratios better than .01%. Enclosed in drawn aluminum can, with terminals. Overall size 6⅞" x 6⅞" x 4½" (high).

Model 201 ..... **$415.00**

● BP SERIES FILTERS

Passive filter units with extreme attenuation outside the pass band (at least 40 db) and sharp cut-off (attenuation rate 80 db per ½ octave). Can be used as low pass, high pass, or band pass.

BP-1 Range 37.5 - 13,600 cps. in half octave steps. Hi and Lo-pass sections can be used in tandem to provide band pass in multiples of ½ octave. 600 ohms. **$2,400.00**

BP-2 Similar to BP-1 but 10 - 160 kc. 135 ohms **1,500.00**

BP-3 Similar to BP-1 but 6.65 - 37.5 cps. 600 ohms **3,675.00**

PS-3 POWER SUPPLY

Regulated power supply for use with FM-3. Provides operation at either 110 or 220 volts. 50/60 cycles. **$50.00**

PS-3C POWER SUPPLY

Cased portable version of the PS-3. Used with FM-3 when both AC and battery operation are desired. **$55.00**

All data and prices are subject to change without notice. Prices shown are F.O.B. factory.

10-55 - LITHO IN U.S.A.

Prepared by Larson-Whittington Assoc., Inc.

Sales representatives in most principal cities of U.S. and Canada. Facilities for export available. For further information contact your nearest Gertsch representative or the factory.

GERTSCH PRODUCTS, INC.

11846 Mississippi Avenue
Los Angeles 25, California
Phone BRadshaw 2-0568

Represented by:

GERTSCH PRODUCTS MODEL PT-1

STANDARD RATIO TRANSFORMER

The Model PT-1 is a precision autotransformer capable of high accuracy and extreme resolution in the measurement of AC voltage ratios.

The PT-1 reads the ratio between the ratio arm and the full winding directly by means of 3 decade push button switches and a ten turn precision potentiometer.

Its chief advantages over a resistance type potentiometer for AC use are:

1) Extreme Accuracy

2) Extremely low source impedance enabling measurements to be made with almost complete freedom from loading effects.

Among the many uses for the PT-1 are the exact measurement of turns ratio in precision transformers, checking the accuracy of AC resolvers, calibration of ACmeters, as a precision AC potentiometer, as a ratio arm in an AC bridge and as an impedance transformer.

SPECIFICATIONS:

Accuracy of Indicated Ratio:

1) ±0.005% from 50 to 3000 cycles, for ratios of .01 or greater. Accuracy decreases above 3000 cycles to approximately ±0.05% at 10 KC.

2) Accuracy of the transformer section only (less 10 turn potentiometer) for ratios greater than 0.01 is better than ±0.001%.

Resolution:	Better than 1 part in 10^6
Source Impedance at Ratio Arm:	7.5 ohms max.
Open Circuit Input Impedance:	Approx. 150 henrys.
Max Input Voltage:	E_{RMS} Max. = .35 F (F in cycles per second). Above 1 KC, E_{RMS} Max = 350 Volts.
Temperature Effects:	Temperature has no effect on accuracy.

GERTSCH PRODUCTS, INC.
11846 Mississippi Avenue,
Los Angeles 25, California